THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 38 JANUARY, 1929 No. 1

RELATIVE VITAMIN A CONTENT OF FOUR ORIENTAL FOODS

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SEVEN TEXT FIGURES

Small quantities of the foods described in this paper were introduced into a basal diet deficient in vitamin A. White albino rats were used as experimental animals. In the experiment with persimmon, a weighed amount of the fresh fruit was fed by hand and then the basal diet was given ad libitum. All of the other foods tested were prepared by cooking in an autoclave for forty minutes at 15 pounds pressure, and dried in a current of air below 60° C. These dry foods were then powdered and incorporated in the basal diet so intimately that the rats could not separate the different food substances. Table 1 shows the results of the experiments.

TABLE 1.—*Showing the results of feeding certain foods to white rats.*

No.	Description or English name of the food tested.	Local name in the Peking dialect and, when possible, in Tagalog.
1	Chinese persimmon	Shih tzŭ (Chinese); called, erroneously, "pagatpat" by the Filipinos.
2	A pot herb with a yellow flower	Huang hua ts'ai (Chinese); called, incorrectly, "bulaklak nang saguing" by the Filipinos.
3	Yellow soy-bean curd (the precipitated proteins of the yellow soy bean).	Tou fu (Chinese); utao (Filipino).
4	------(?)	Kan lu.

[1] The work at the Peking Union Medical College was done with the help of Mr. Tsan Ch'iang Wang, to whom much credit is due.

TABLE 1.—*Showing the results of feeding certain foods to white rats.*—Cont.

No.	Scientific name.	Minimum amount of food tested necessary for normal growth and the prevention of xerophthalmia.	Remarks.
1	*Diospyros kaki* Linnæus f.....	Two grams of fresh persimmon daily cures xerophthalmia; 5 grams daily gives normal growth.	Abundant source of vitamin A.
2	*Hemerocallis flava* Linnæus....	Five per cent of the total diet cures xerophthalmia and gives normal growth.	Do.
3	*Glycine max* Linnæus.....	Thirty per cent of the total diet gave stable weight, but the growth was subnormal.	Fair amount of vitamin A.
4	------(?)-----------	Forty per cent of the total diet gave subnormal growth.	Small amount of vitamin A.

CONCLUSIONS

Chinese persimmon and the flower of *Hemerocallis flava* Linnæus (huang hua ts'ai) are rich in vitamin A. Bean curd has only a moderate amount of vitamin A, and kan lu has an even lower vitamin A content.

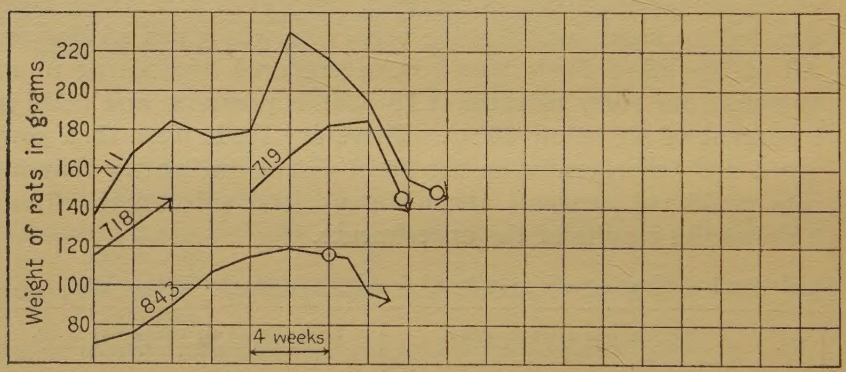

FIG. 1. Rats 711, 718, 719, and 843 received the basal diet which consisted of purified dry casein (extracted with absolute alcohol three times) 18 per cent. Our standard salt mixture consisted of sodium chloride (NaCl), 0.173 gram; magnesium sulphate ($MgSO_4$), 0.266 gram; sodium sulphate (NaH_2PO_4), 0.347 gram; dipotassium phosphate (K_2HPO_4), 0.954 gram; calcium phosphate [$CaH_4(PO_4)_2$], 0.540 gram; ferric citrate, 0.118 gram; and calcium lactate, 1,300 grams. This salt mixture, 4 per cent; dry brewers' yeast (extracted with absolute alcohol three times); purified dry starch prepared from mung bean (extracted with absolute alcohol three times), 68 per cent. All of the rats died, and all showed severe xerophthalmia. This disease developed more rapidly in young rats given the diet than it did in the old ones.

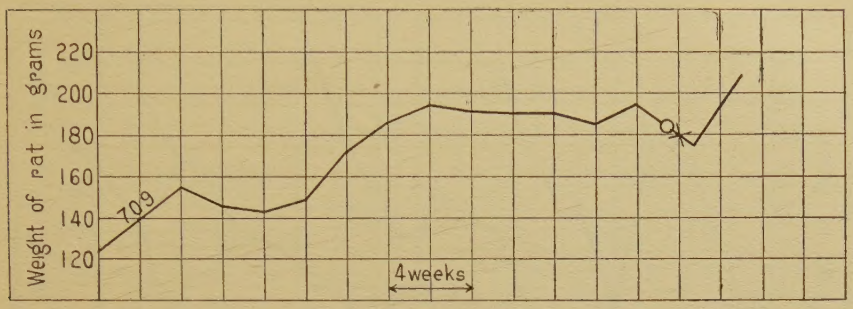

FIG. 2. Rat 709, fed the basal diet, developed a severe case of xerophthalmia. This was cured by the feeding of 2 grams of fresh Chinese persimmon daily in addition to the basal diet. The cross indicates where 2 grams of persimmon were added to the diet.

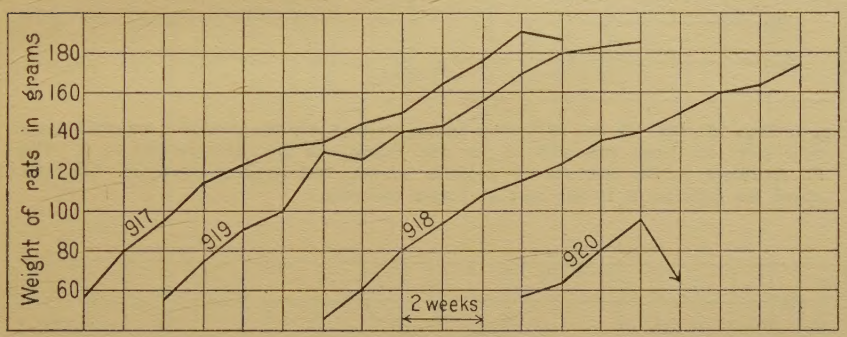

FIG. 3. Rats 917, 918, and 920 received 5 grams of fresh persimmon daily, in addition to the basal diet. They showed good growth and no signs of xerophthalmia. Rat 920 died after a few weeks. A post-mortem examination showed pneumonia.

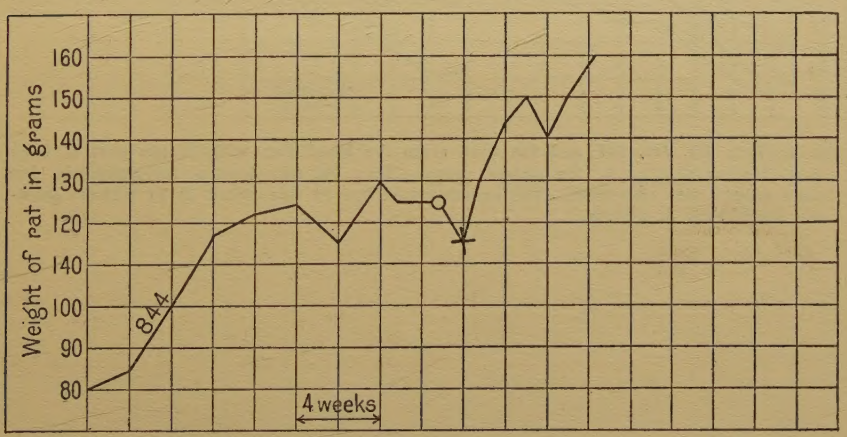

FIG. 4. Rat 844, fed the basal diet, developed a severe case of xerophthalmia. This was cured by deducting 5 per cent of starch and replacing it with 5 per cent of huang hua ts'ai. The cross shows the addition of 5 per cent huang hua ts'ai.

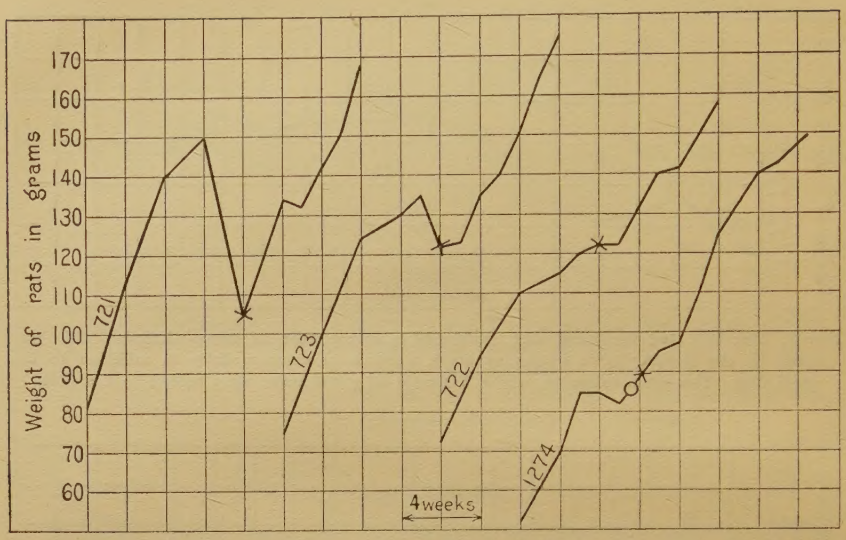

FIG. 5. Rats 721, 722, 723, and 1274, after having received only the basal diet for eight weeks, were given the basal diet with 10 per cent huang hua ts'ai incorporated in it. They all recovered weight and showed excellent growth and physical condition. The cross shows the addition of 10 per cent of huang hua ts'ai.

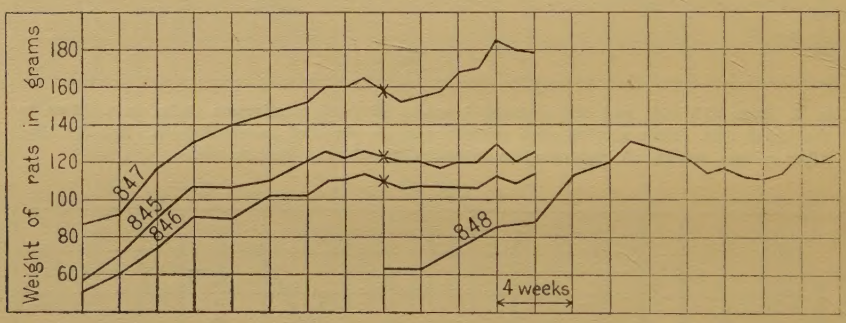

FIG. 6. Rats 845, 846, 847, and 848 were given the basal diet, with 10 per cent of bean curd incorporated in it, for sixteen weeks. They did not develop xerophthalmia, but their growth was subnormal. The percentage of tou fu was raised to 30 without showing much gain in growth.

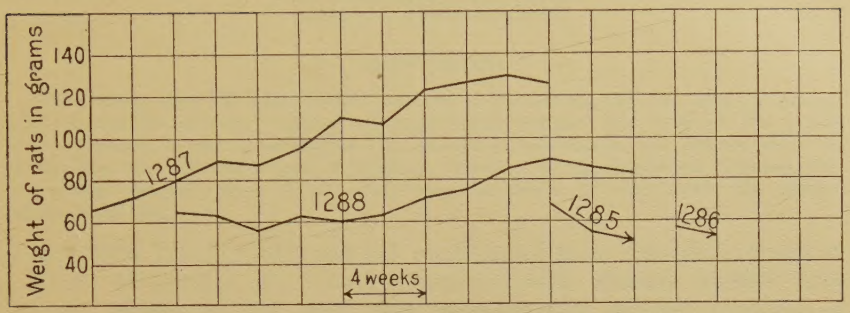

FIG. 7. Rats 1285, 1286, 1287, and 1288 were fed the basal diet with 40 per cent of kan lu incorporated in it. In the beginning of the experiment rats 1285 and 1286 died of pneumonia. Rats 1287 and 1288 did not develop xerophthalmia, but their growth was subnormal.

ILLUSTRATIONS

TEXT FIGURES

[The charts show the identification numbers of the guinea pigs, the rates of growth, and the number of weeks' duration of experimental feeding. The circle on the growth curve indicates severe xerophthalmia. An arrowhead terminating the growth curve indicates the death of the animal in question. Omission of the arrowhead indicates that the animal was still living at the end of the experiment. A cross means the addition of the tested food.]

FIG. 1. Rats 711, 718, 719, and 843 received the basal diet which consisted of purified dry casein (extracted with absolute alcohol three times) 18 per cent. Our standard salt mixture consisted of sodium chloride (NaCl), 0.173 gram; magnesium sulphate ($MgSO_4$), 0.266 gram; sodium sulphate (NaH_2PO_4), 0.347 gram; dipotassium phosphate (K_2HPO_4), 0.954 gram; calcium phosphate [$CaH_4(PO_4)_2$], 0.540 gram; ferric citrate, 0.118 gram; and calcium lactate, 1.300 grams. This salt mixture, 4 per cent; dry brewers' yeast (extracted with absolute alcohol three times); purified dry starch prepared from mung bean (extracted with absolute alcohol three times), 68 per cent. All of the rats died, and all showed severe xerophthalmia. This disease developed more rapidly in young rats given the diet than it did in the older ones.

2. Rat 709, fed the basal diet, developed a severe case of xerophthalmia. This was cured by the feeding of 2 grams of fresh Chinese persimmon daily in addition to the basal diet. The cross indicates where 2 grams of persimmon were added to the diet.
3. Rats 917, 918, and 920 received 5 grams of fresh persimmon daily, in addition to the basal diet. They showed good growth and no signs of xerophthalmia. Rat 920 died after a few weeks. A post-mortem examination showed pneumonia.
4. Rat 844, fed the basal diet, developed a severe case of xerophthalmia. This was cured by deducting 5 per cent of starch and replacing it with 5 per cent of huang hua ts'ai. The cross shows the addition of 5 per cent huang hua ts'ai.
5. Rats 721, 722, 723, and 1274, after having received only the basal diet for eight weeks, were given the basal diet with 10 per cent huang hua ts'ai incorporated in it. They all recovered weight and showed excellent growth and physical condition. The cross shows the addition of 10 per cent of huang hua ts'ai.
6. Rats 845, 846, 847, and 848 were given the basal diet, with 10 per cent of bean curd incorporated in it, for sixteen weeks. They did not develop xerophthalmia, but their growth was subnormal. The percentage of tou fu was raised to 30 without showing much gain in growth.
7. Rats 1285, 1286, 1287, and 1288 were fed the basal diet with 40 per cent of kan lu incorporated in it. In the beginning of the experiment rats 1285 and 1286 died of pneumonia. Rats 1287 and 1288 did not develop xerophthalmia, but their growth was subnormal.

RELATIVE CONTENT OF WATER-SOLUBLE VITAMIN B IN THIRTY ORIENTAL FOODS

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THIRTY-SEVEN TEXT FIGURES

Thirty oriental foods were tested for their relative content of vitamin B. On account of the impossibility of obtaining albino rats when these experiments were started, the initial experiments were done using Chinese white mice and the standard growth curves were previously published.[2] Later the results were checked by feeding some of the same foods to white albino rats. In every case the original results were confirmed, but a slightly higher percentage of the total diet was required to protect the mice from beriberi than was required to protect the rats. The experiments with mice can then be accepted as showing the presence or absence of vitamin B in the foods tested and its relative abundance in these foods.

Only the growth curves showing the minimum percentage of the food tested which protected from beriberi are included in this article.

CONCLUSIONS

1. The following foods are deficient in vitamin B, and do not protect from beriberi at any feeding level: Chinese persimmon (*Diospyros kaki* Linnæus); water chestnut (*Eleocaris tuberosa* Naves); fermented rice, or lao mi (*Oryza sativa* Linnæus); and locust seed (*Robinia pseudoacacia*).

2. Hsiang ch'un, the leaf of *Cedrela sinensis*, contains a poison which causes violent convulsions and death when fed in concentrated form. Wo sun (perhaps a variety of *Lactuca sativa* Linnæus), hao tzu kan (*Chrysanthemum coronarium* Lin-

[1] Most of the laboratory work in these experiments was done at the Peking Union Medical College, with the help of my assistant, Mr. Tsan Ch'ing Wang, to whom much credit is due. The work was completed at the Bureau of Science, Manila.

[2] Embrey, H., China Med. Journ. 35 (1921) 420.

næus), and p'ieh lan (apparently a variety of *Brassica campestris* Linnæus) are not growth producing when fed at high levels, even when added to a complete diet, thus apparently showing the presence of substances that are harmful in very great concentrations.

3. All of the other foods tested—ch'ia ts'ai (*Phaseolus aureus* Roxburgh), huang tou (*Soya max* Linnæus), huang tou ya (sprouts of *Soya max* Linnæus), ch'ing tou (green variety of *Soya max* Linnæus), ch'ing tou ya (the sprouts of the green variety of *Soya max* Linnæus), hung kao liang (red variety of *Sorghum vulgare* Persoon), pai kao liang (white variety of *Sorghum vulgare* Persoon), t' zu ku (*Sagittaria sagittaefolia* Linnæus), wo kua (probably a variety of *Cucurbita pepo* Linnæus), huang hua ts'ai (probably *Hemerocallis flava* Linnæus), chieh ts'ai ying (probably a variety of *Brassica campestris* Linnæus), hu tzu (variety of *Lagenaria vulgaris* Seringe), ssu kua (*Luffa cylindrica* Linnæus), weng ts'ai (a Chinese variety of *Ipomoea reptans* Poiret), upo (a Filipino variety of *Lagenaria vulgaris* Seringe), chico (*Achras sapota* Linnæus), tou fu (bean curd from *Soya max* Linnæus), hsi hulu (probably a variety of *Cucurbita pepo* Linnæus), tung kua (a Chinese variety of *Benincasa hispida* Cogniaux), kan lu (not identified), and papaya (*Carica papaya* Linnæus)—are sources of vitamin B in varying amounts. Chico, hsi hu lu, and tung kua are low in this vitamin.

EXPLANATION OF THE CHARTS

The charts show the identification numbers of the white mice or white rats, the growth curves of the animals used in the experiments, and the number of weeks' duration of experimental feeding.

The numbers above the growth curves are the identification numbers of the animals. The weights of the animals are shown by the figures on the axes of ordinates, and the number of weeks of experimentation is indicated by the numbers on the axes of abscissæ. An arrowhead terminating the growth curve indicates the death of the animal in question. Omission of the arrowhead indicates that the animal was still living at the end of the experiment.

The foods used in the basal diet were prepared in the following way:

The casein was repeatedly dissolved in dilute alkali, and reprecipitated until the ash content was less than 0.7 per cent.

The casein thus obtained was extracted with 80 per cent alcohol, and then with ether, and dried at 100° C.

The starch, made commercially from mung beans, was heated with 0.5 per cent citric acid for four hours at 15 pounds pressure. The dextrinized starch was subsequently washed with 80 per cent alcohol and dried.

Our standard salt mixture consisted of sodium chloride, 0.173 gram; dipotassium hydrogen phosphate, 0.954 gram; magnesium sulphate, 0.266 gram; monosodium phosphate, 0.347 gram; monocalcium phosphate, 0.540 gram; ferric citrate, 0.118 gram; and calcium lactate, 1.300 grams.

Butter was melted below 45° C., and the clear liquid was decanted and centrifuged an hour. This butter fat was used as the source of fat-soluble A.

The foods investigated for vitamin B content, unless otherwise stated, were cooked forty minutes in an autoclave at 15 pounds pressure, and dried in a current of air below 60° C. The food under investigation was introduced into the basal diet by diminishing the amount of starch by the same percentage as that of the food used. The ingredients of the diets were ground so fine that the animals were unable to separate them.

TABLE 1.—*Foods fed to Chinese mice.*

Test No. and description or English name of food tested.	Local name in Peking dialect and, when possible, also in Tagalog.	Scientific name.	Percentage of the food tested necessary in a beriberi diet for normal growth and reproduction.	Remarks.
1. Sprout of the mung bean with root removed.	Ch'ia ts'ai	*Phaseolus aureus* Roxburg	Fifteen per cent	Plentiful source of vitamin B.
2. Heads of the mung bean sprouts.	do	do	do	This test was made to see if the vitamin was concentrated in one part of the vegetable.
3. Yellow soy bean	Huang tou	*Soya max* Linnæus	do	Plentiful source of vitamin B.
4. Yellow soy-bean sprout	Huang tou ya	do	Normal growth, 15; normal reproduction, 20.	Do.
5. Green soy bean	Ch'ing tou	do	Fifteen per cent	Do.
6. Green soy-bean sprout	Ch'ing tou ya	do	Normal growth, 15; normal reproduction, 20.	Do.
7. Red variety	Hung kaoliang	*Sorghum vulgare* Persoon	Almost normal growth, 30	This is commonly used as a grain in North China in place of rice.
8. White variety	Pai kaoliang	do	Normal growth, 25; normal reproduction, 35.	Used as a rice substitute in North China.
9. No English equivalent	T'zu ku	*Sagittaria sagittaefolia* Linnæus.	Twenty-five per cent	Plentiful source of vitamin B.
10. A crook-necked gourd, often called "Japanese gourd."	Wo kua	Probably a variety of *Cucurbita pepo* Linnæus.	Normal growth at 50; no reproduction at that level.	Low in vitamin B.
11. A pot herb with a yellow flower.	Huang hua ts'ai	Probably *Hemerocallis flava* Linnæus.	Normal growth, 30; no reproduction at that level.	Moderate amount of vitamin B.
12. A green leaf vegetable	Chieh ts'ai ying	Probably *Brassica campestris* Linnæus.	Normal growth, 30; reproduction at that level subnormal.	Do.
13. An edible gourd	Hu tzu (Chinese); similar to the upo (Filipino).	Variety of *Lagenaria vulgaris* Seringe.	Normal growth at 40; reproduction subnormal at that level.	Do.

14. Edible tuber called by Americans "water chestnut."	Pi ch'i (Chinese); Apulid Tsina (Filipino).	*Eleocaris tuberosa* Naves	Seventy-three per cent of the total diet did not protect from beriberi.	Deficient in vitamin B.
15. Locust seed	Huai tzu	*Robinia pseudoacacia*	With 70 per cent of the total diet, all died from beriberi.	In severe famines this is often the main food. Deficient in vitamin B.
16. Tribute Manchu rice, which fermented and was sold as a food delicacy. It is called "old rice."	Lao mi	*Oryza sativa* Linnæus	At 73 per cent of the total diet, all died of beriberi.	Deficient in vitamin B.
17. Chinese persimmon	Shih tzu	*Diospyros kaki* Linnæus	When fed ad libitum, all died from beriberi.	Do.
18. Leaf of a tree in North China used as a vegetable in the spring.	Hsiang ch'un	Probably *Cedrela sinensis*	Impossible to test for vitamin B, on account of a toxic substance present in the food.	Even when added to a complete diet, a toxin in the food caused convulsions and death.
19. A lettuce root	Wo sun	Perhaps a variety of *Lactuca sativa* Linnæus. It has also some characteristics of a *Brassica*.	At 60 per cent level mice lose weight and live only from six to eight weeks.	Very low in vitamin B.
20. A long, mottled, green vegetable with lengthwise ridges.	Ssu kua (Chinese); Kastila (Filipino).	*Luffa cylindrica* (Linnæus) M. Roemer.	With 50 per cent of the diet, stable weight was maintained. Growth and reproduction were subnormal.	Low in vitamin B.

TABLE 2.—*Foods fed to albino rats.*

Test No. and description or English name of food tested.	Local name in Peking dialect and, when possible, also in Tagalog.	Scientific name.	Percentage of the food tested necessary in a beriberi diet for normal growth and reproduction.	Remarks.
21. Repetition of test 18, using rats instead of mice.	Hsiang ch'un	Probably *Cedrela sinensis*	No result on vitamin B, on account of the presence of a toxin.	Result in test 18 confirmed. A toxic substance caused convulsions and death.
22. Repetition of test 19, using rats instead of mice.	Wo sun	Probably *Lactuca sativa* Linnæus.	At 60 per cent level animals all lost weight.	At high concentrations the animals lost weight and disliked their food.
23. An edible green leaf	Weng ts'ai (Chinese); kankang (Filipino).	Variety of *Ipomoea reptans* Poir.	Forty per cent protected from beriberi fourteen weeks. Growth subnormal.	Moderate amount of vitamin B present.
24. A bottle gourd	Upo (Filipino), similar to Chinese hu tzu.	Variety of *Lagenaria vulgaris* Seringe.	Twenty-five per cent gave almost normal growth. Reproduction almost normal.	Plentiful source of vitamin B.
25. A fruit called chico in English.	Chico (Filipino)	*Achras sapota* Linnæus	Almost normal growth, 55	Vitamin B content low.
26. Papaya	Papaya (Filipino)	*Carica papaya* Linnæus	Normal growth, 25; reproduction, 35.	Source of vitamin B.
27. Soy-bean curd. Proteins precipitated from the yellow soy bean.	Tou fou	*Soya max* Linnæus	Normal growth and reproduction, 20.	Plentiful source of vitamin B.
28. A vegetable marrow	Hsi hu lu	Probably a variety of *Cucurbita pepo* Linnæus.	At 60 per cent weight is maintained. Growth and reproduction subnormal.	Very low in vitamin B.
29. An edible green leaf	Hao tzu kan (Chinese); Tanñgu (Filipino).	*Chrysanthemum coronarium* Linnæus.	At 60 per cent only one animal survived.	When added to a complete diet at high concentrations growth was subnormal.

30. A kohl-rabi	P'ieh lan	Apparently a variety of *Brassica campestris* Linnæus.	At 40 per cent level animals lived four months. At 60 per cent level rats lived three to six weeks.	Animals died from beriberi at low levels of feeding. At higher levels the food did not agree with the animals.
31. A melon-shaped vegetable	Tung kua (Chinese); kondol	*Benincasa hispida* Cogniaux	Sixty per cent protected from beriberi for two months, but growth was subnormal.	Very low in vitamin B.
32. Not identified	Kan lu (Pekingese)	Not identified; probably *Stachys sieboldi* Miquel.	Ten per cent gave normal growth.	Plentiful source of vitamin B.

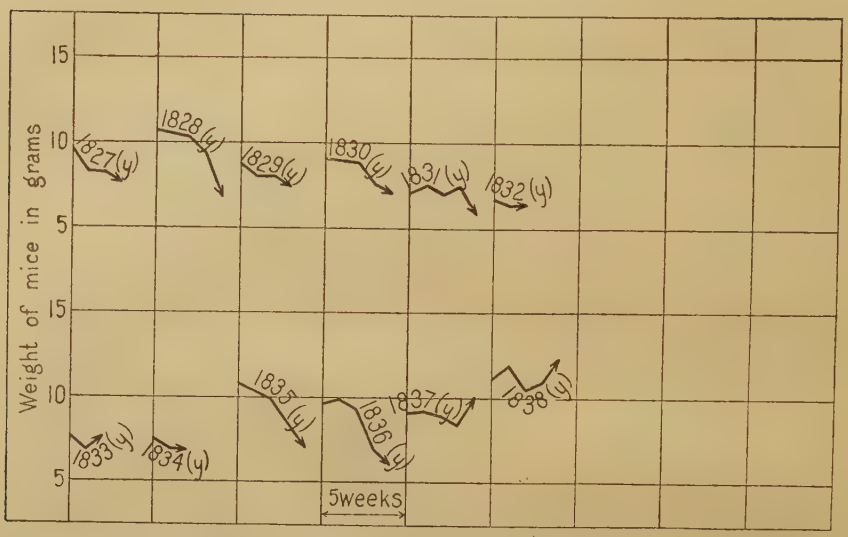

FIG. 1. These mice received the following basal diet: Casein, 18 per cent; a mixture of salts, 4 per cent; starch, 73 per cent; butter, 5 per cent.

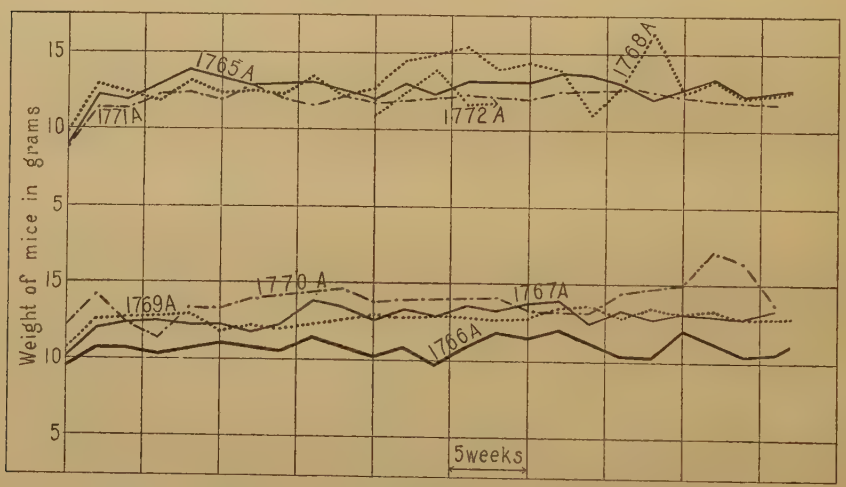

FIG. 2. These mice received the basal diet described under fig. 1 with 15 per cent of ch'ia ts'ai incorporated in the diet by substituting the ch'ia ts'ai for 15 per cent of starch. All of the foods tested were incorporated in the basal diet in the same manner by substitution for an equivalent amount of starch. The second generation on the basal diet and 15 per cent of ch'ia ts'ai showed excellent growth.

FIG. 3. These mice received the basal diet with 15 per cent of the heads of mung-bean sprouts incorporated in it. This diet was given in order to determine whether the vitamin B content of the sprouts was concentrated more in one part of the plant than in another. The second generation on diet showed excellent growth.

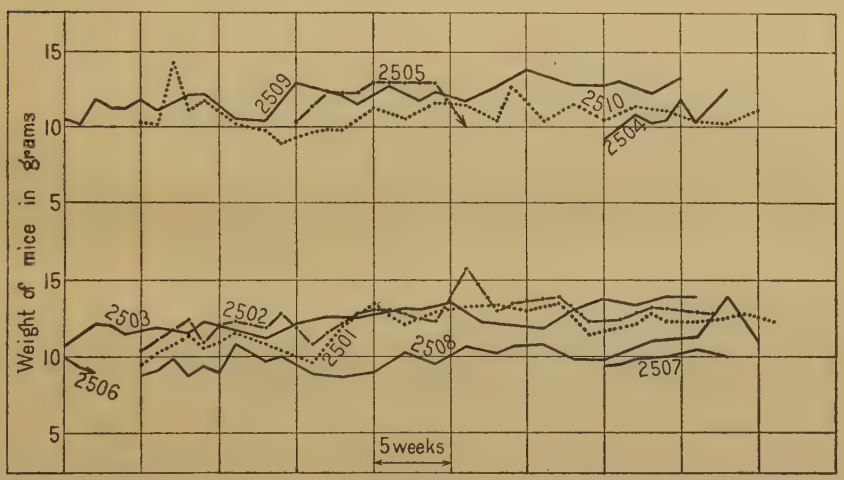

FIG. 4. These mice received 15 per cent of yellow soy bean incorporated in the basal diet. The second generation on this diet were having good growth when the experiment was terminated.

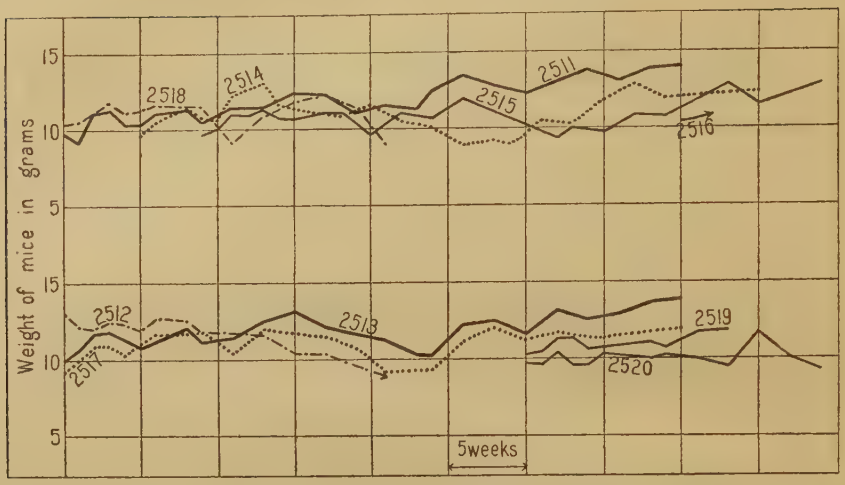

FIG. 5. These mice received 15 per cent of yellow soy-bean sprout incorporated in the basal diet. They showed fair growth and presented no signs of beriberi. Reproduction and growth of the second generation were, however, subnormal when only 15 per cent of yellow soy-bean sprout was used.

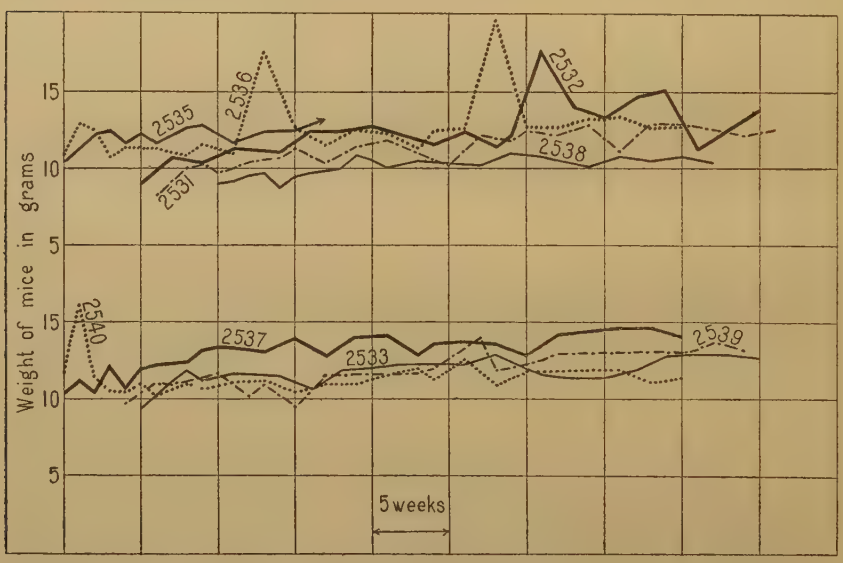

FIG. 6. These mice received 20 per cent of yellow soy-bean sprout incorporated in the diet. They had normal growth and reproduction.

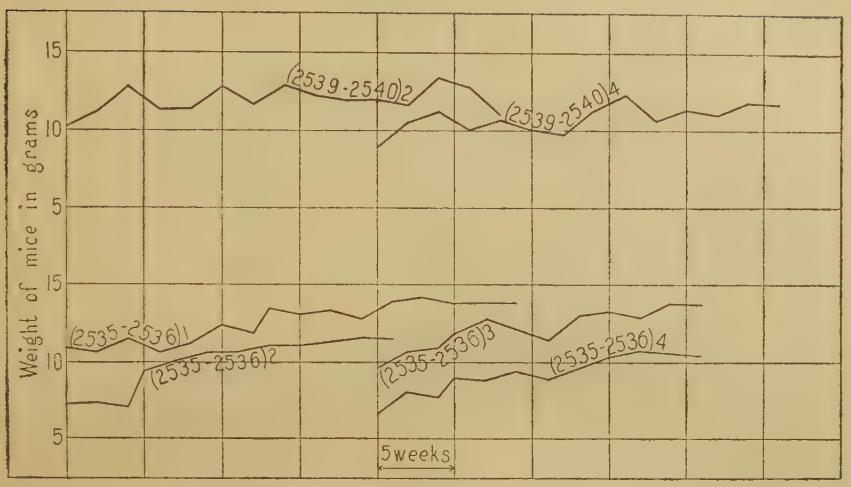

FIG. 7. These mice were the second generation on a diet of 20 per cent yellow soy bean. They all had normal growth.

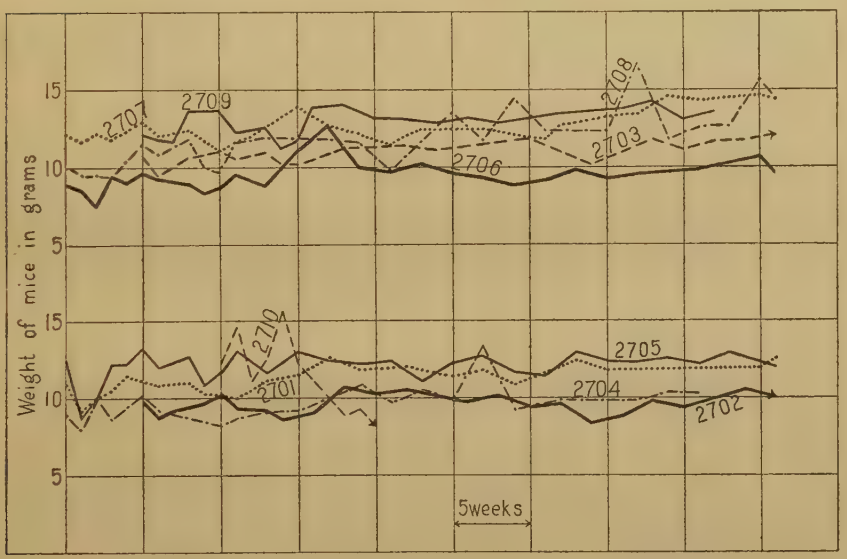

FIG. 8. These mice received 15 per cent of green soy bean incorporated in the basal diet. They showed good growth in the first generation.

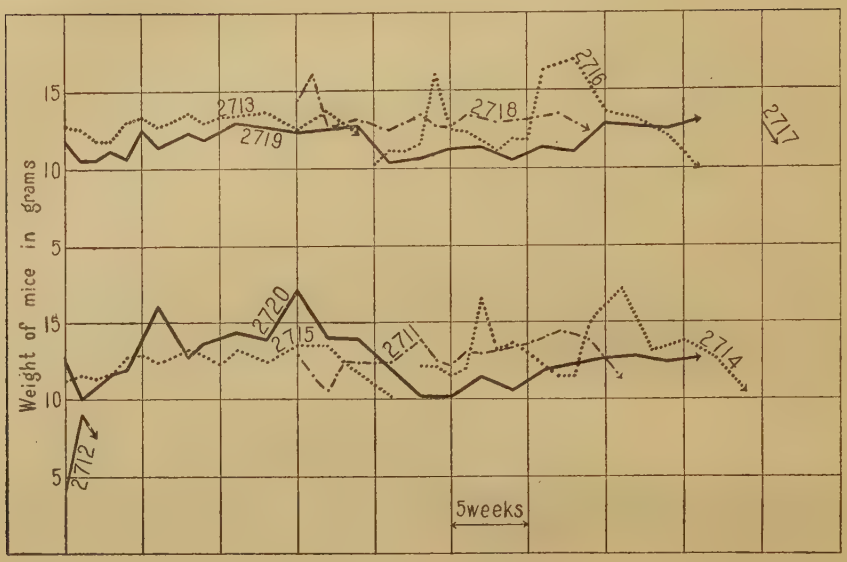

FIG. 9. These mice received 15 per cent of sprouted green soy bean incorporated in the basal diet. The first generation almost normal growth, but only two of the second generation survived the period of lactation. When 20 per cent of sprouted green soy bean was given, both the first and the second generation grew normally.

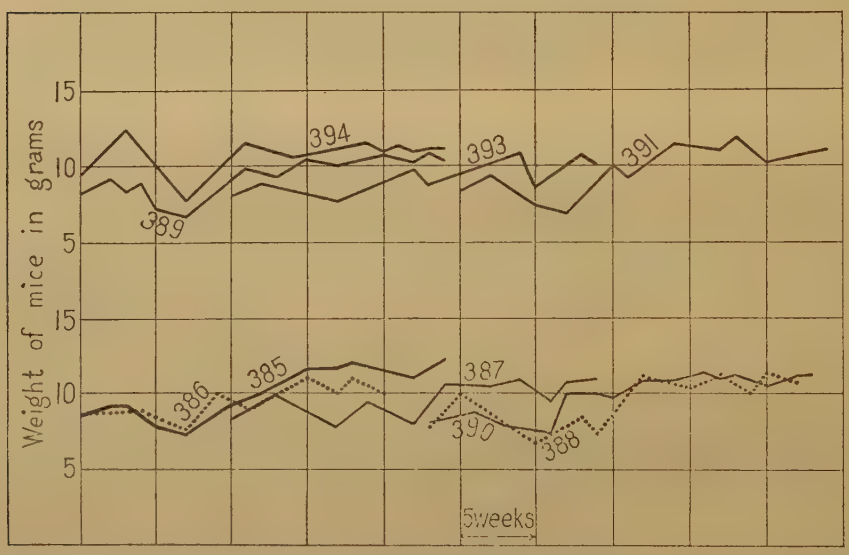

FIG. 10. These mice received 30 per cent of the red variety of kaoliang. Growth was normal, but none of the second generation lived.

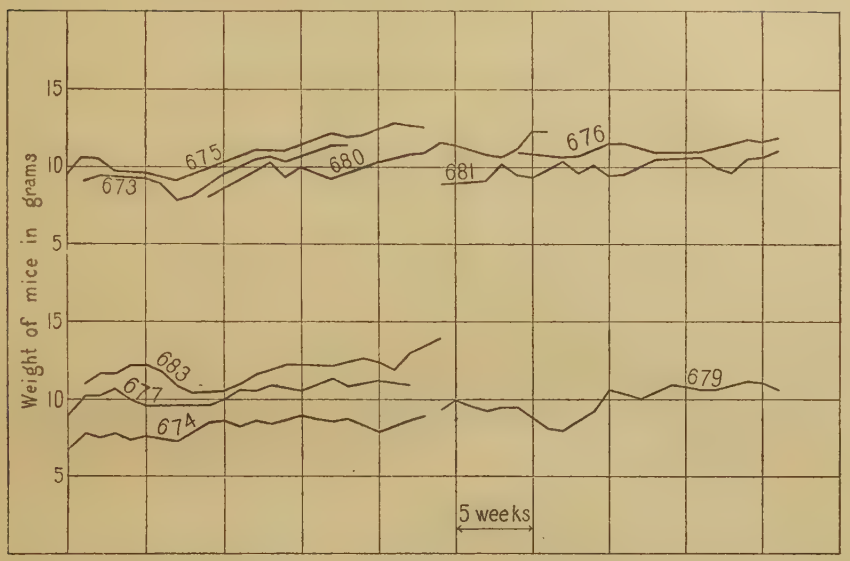

FIG. 11. These mice received 25 per cent of the white variety of kaoliang. Two of the second and three of the third generation lived on this diet. The rate of reproduction was subnormal, however.

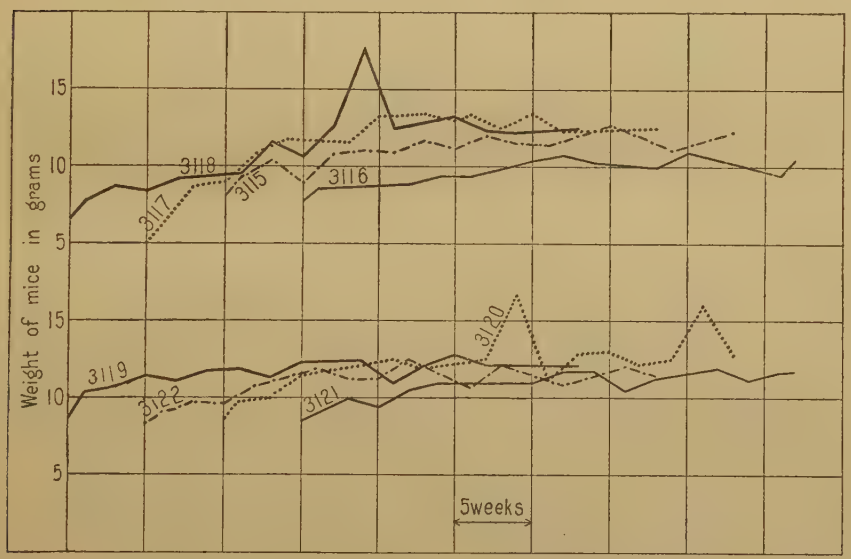

FIG. 12. These mice received 25 per cent of t'zu ku incorporated in the basal diet. They were protected from beriberi and had normal growth. Four of the second generation lived.

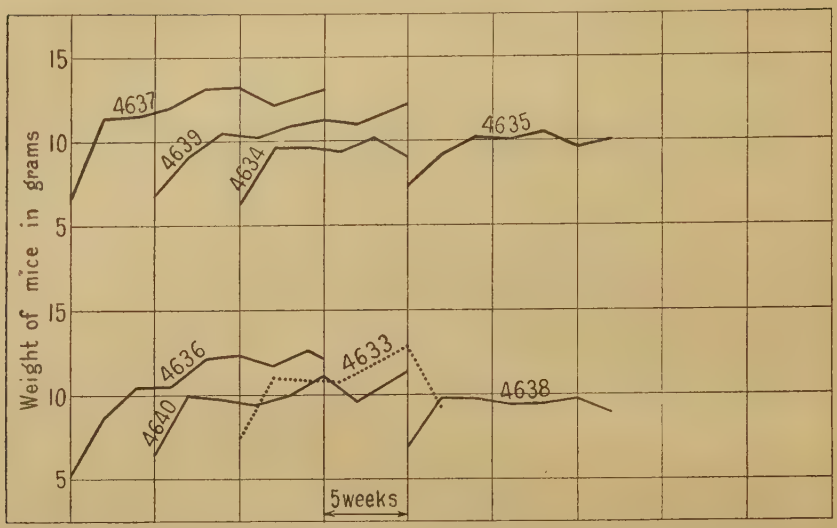

FIG. 13. These mice received 50 per cent of wo kua incorporated in the basal diet. All of the mice were protected from beriberi during the time of the experiment, and the growth of the first generation was almost normal. There was no reproduction on this diet.

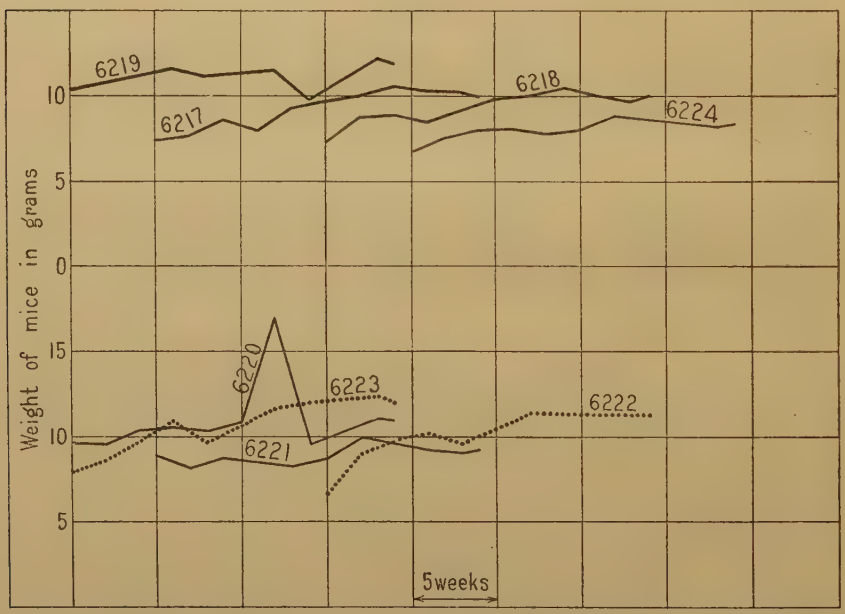

FIG. 14. These mice received 30 per cent of huang kua ts'ai and the basal diet. Growth of the first generation was normal. None of the young lived.

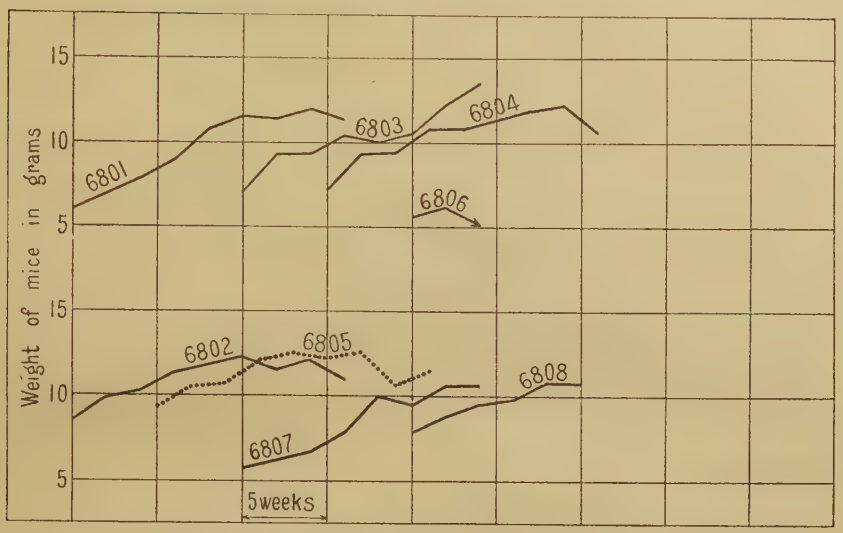

FIG. 15. These mice received 30 per cent of chieh ts'ai ying and the basal diet. The growth of the first generation was almost normal, but the rate of reproduction was subnormal.

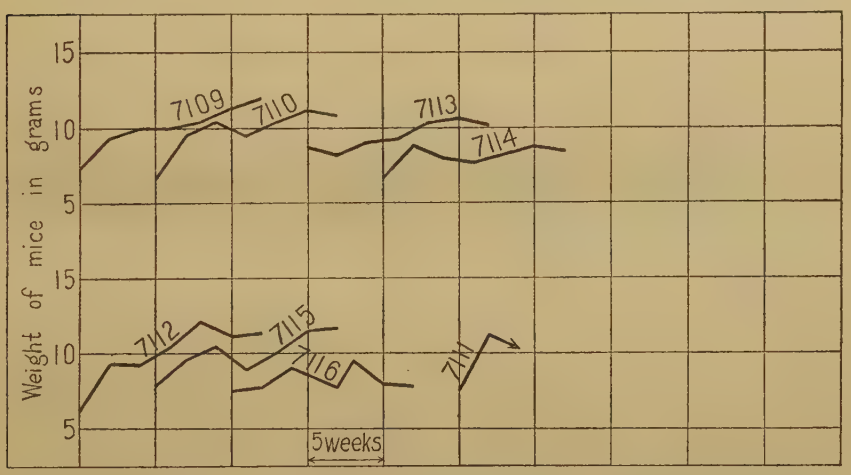

FIG. 16. These mice were given 40 per cent of hu tzu and the basal diet. The growth of the first generation was almost normal. Reproduction was subnormal.

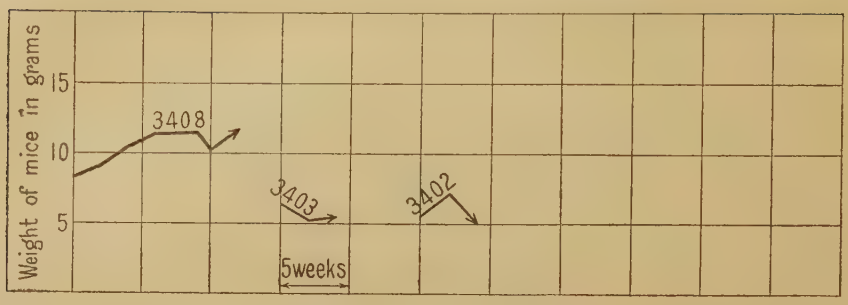

FIG. 17. These mice were given the basal diet with 73 per cent of pi ch'i incorporated in it. They all died of beriberi, thus proving that pi ch'i is deficient in vitamin B. Only one mouse lived longer than three weeks.

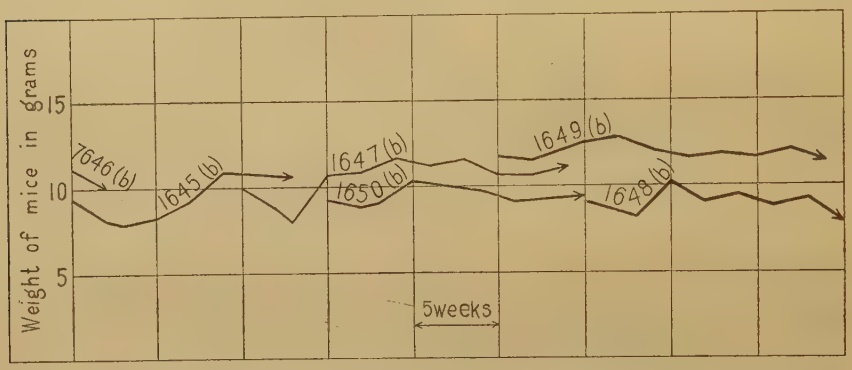

FIG. 18. These mice were given the basal diet with 70 per cent of locust seed incorporated in it. They lived from twelve to twenty weeks, but finally died of beriberi, thus proving that, while locust seed contain relatively a little more of vitamin B than does pi ch'i, both of these foods are deficient in this vitamin.

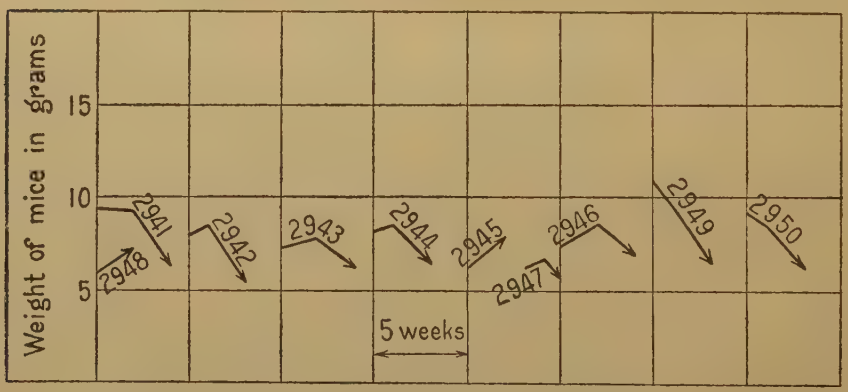

FIG. 19. These mice were given 73 per cent of lao mi incorporated in the basal diet. All of them died from beriberi in from two of three weeks.

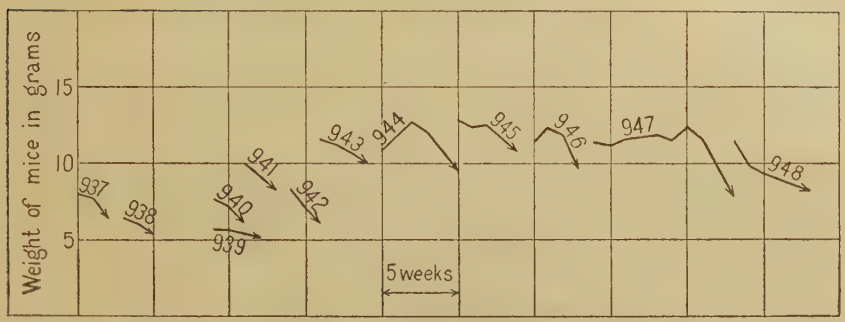

FIG. 20. These mice received the basal diet and fresh persimmon ad libitum. They all died from beriberi in from two to seven weeks, thus proving that persimmon is deficient in vitamin B.

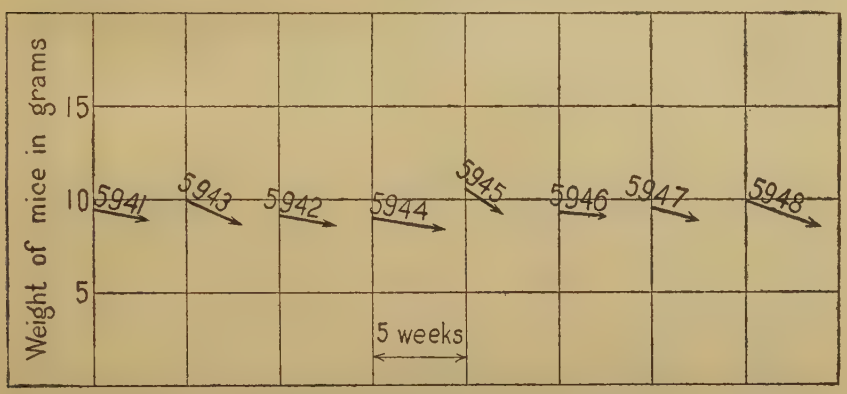

FIG. 21. These mice received the basal diet with 60 per cent of hsiang ch'un incorporated in it. There is evidently a toxic principle in hsiang ch'un which causes convulsions and death after a couple of weeks of a diet containing a high level of hsiang ch'un. The mice died from the effects of a poison, and not from the usual beriberi symptoms. This toxin should be investigated further.

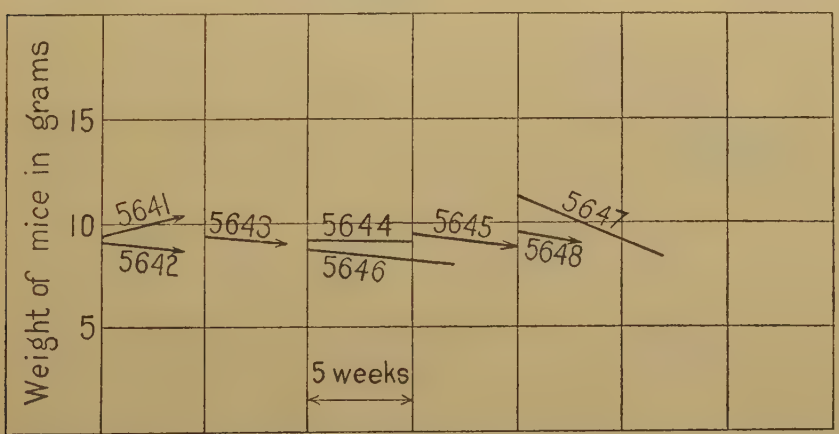

FIG. 22. These mice received 60 per cent of wo sun in the basal diet. They lost weight and lived only from six to eight weeks.

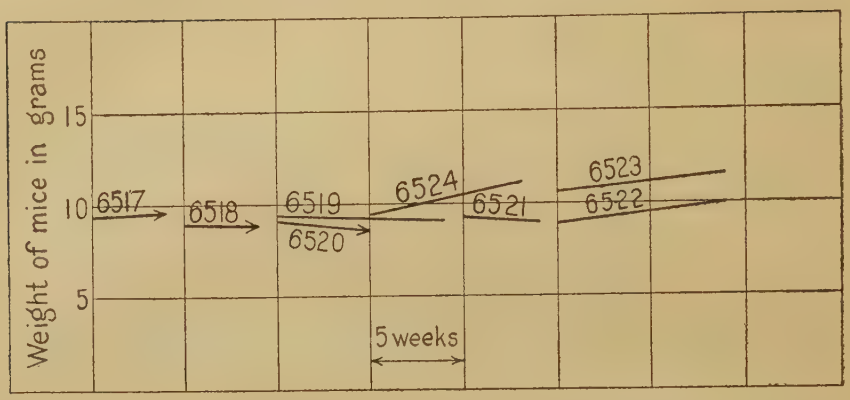

FIG. 23. These mice received 50 per cent of ssu kua incorporated in the basal diet. Four of the mice were living after eight weeks on this diet. Their growth was subnormal. The results show the presence of vitamin B, but in relatively small amounts.

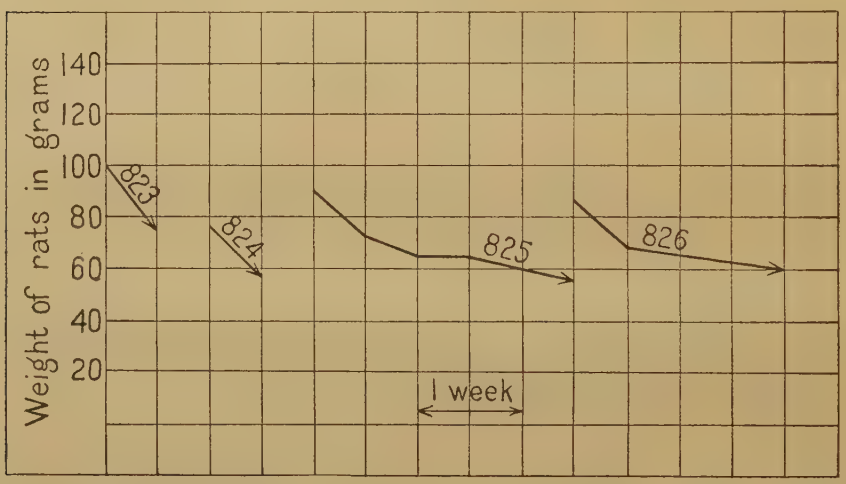

FIG. 24. A diet of hsiang ch'un, 63 per cent; casein, 18 per cent; a mixture of salts, 4 per cent; butter, 5 per cent; and yeast, 10 per cent was given to albino rats. These rats died after having convulsions, thus confirming the results obtained with mice, and proving the toxic effect of hsiang ch'un even with a diet affording ample vitamin B.

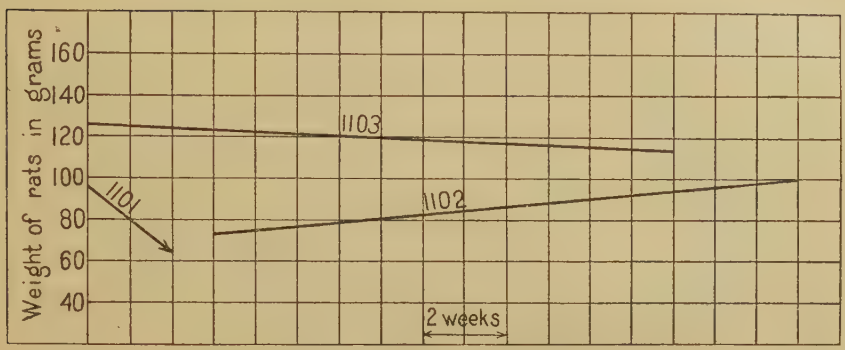

FIG. 25. These albino rats received 40 per cent of weng ts'ai incorporated in the basal diet. This amount of food supplied enough vitamin B to protect the rats from beriberi, but not enough to insure normal growth and reproduction.

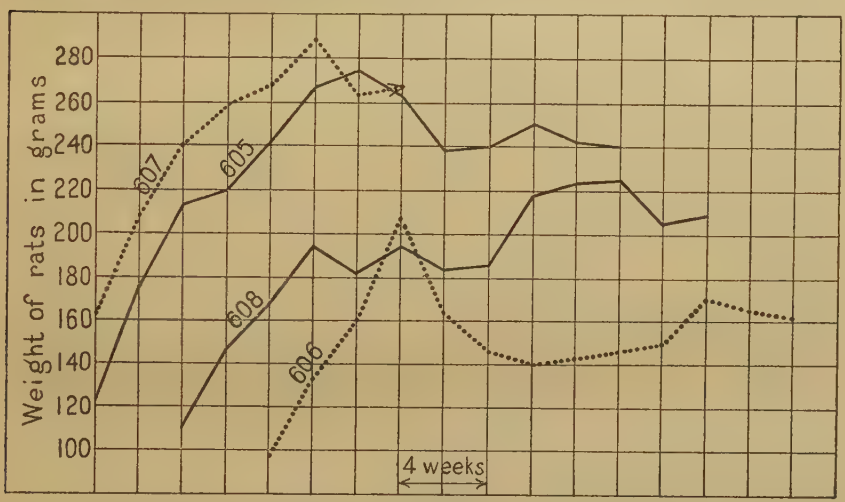

FIG. 26. Twenty-five per cent of Philippine upo in the basal diet gave good growth and a fair rate of reproduction in the case of three albino rats. This result proves that upo is a plentiful source of vitamin B.

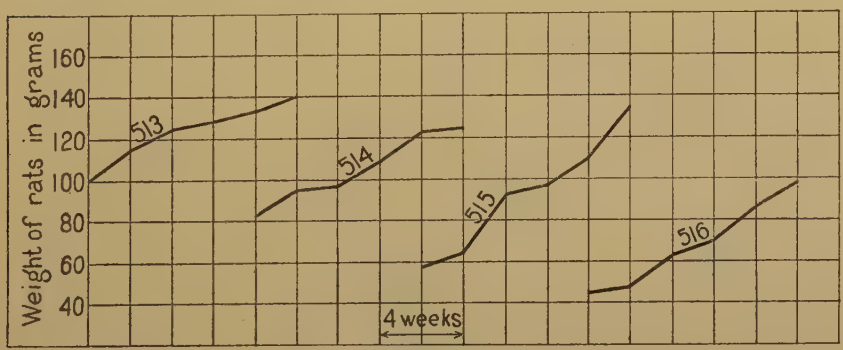

FIG. 27. Fifty-five per cent of chico protected four albino rats from beriberi for a period of ten weeks.

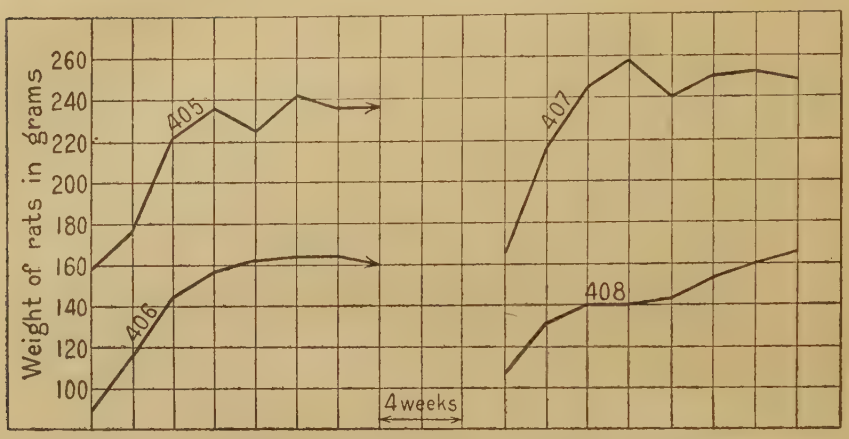

FIG. 28. Twenty-five per cent of papaya protected two albino rats from beriberi for a period of ten weeks, but growth was not normal.

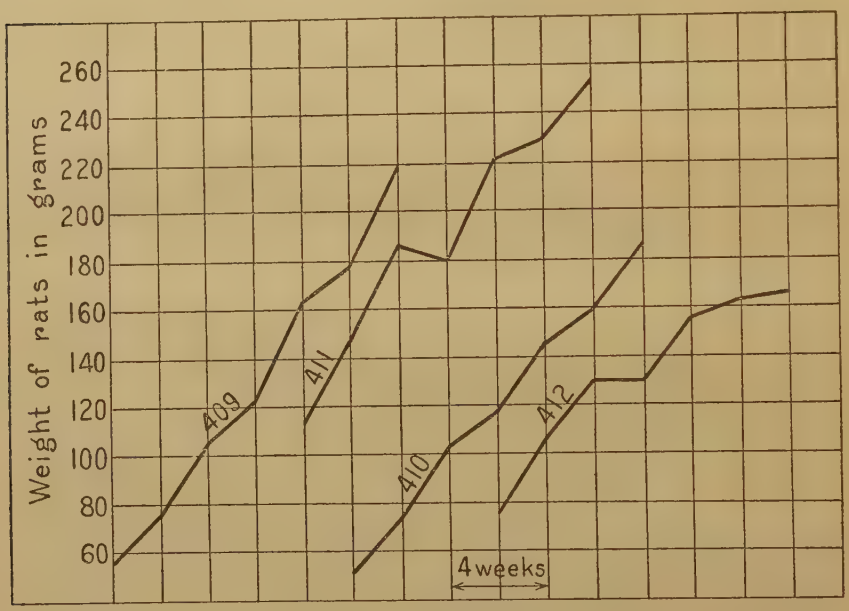

FIG. 29. Thirty-five per cent of papaya in the basal diet gave excellent growth.

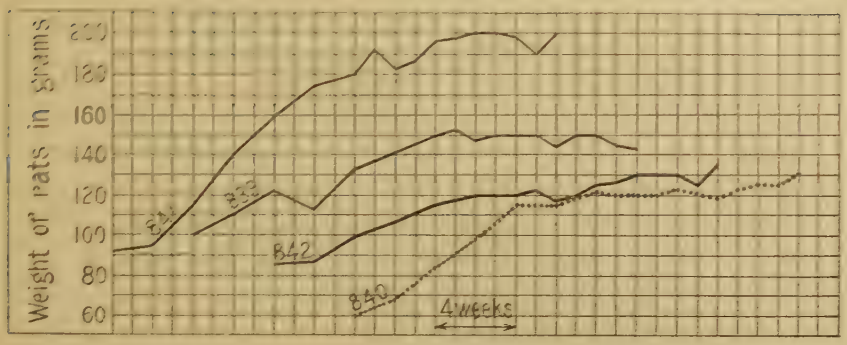

FIG. 30. Twenty per cent of commercial bean curd made from yellow soy bean protected four albino rats from beriberi for twenty-two weeks. This result shows that most of the vitamin B content of the original yellow soy bean appears in the commercial bean curd. This fact should be of practical value, since bean curd and rice often constitute the entire meal of poor Chinese.

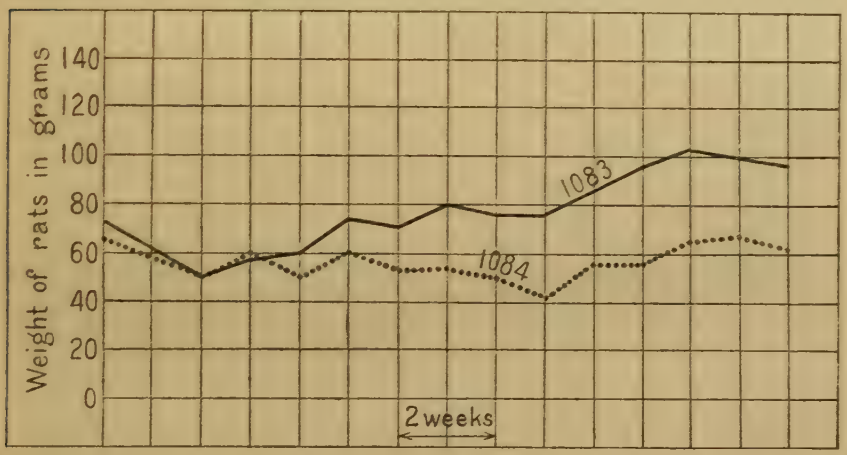

FIG. 31. Sixty per cent of hsi hu lu in the basal diet protected two albino rats from beriberi for fourteen weeks. This result proves the presence of vitamin B in this food, but only in small amount.

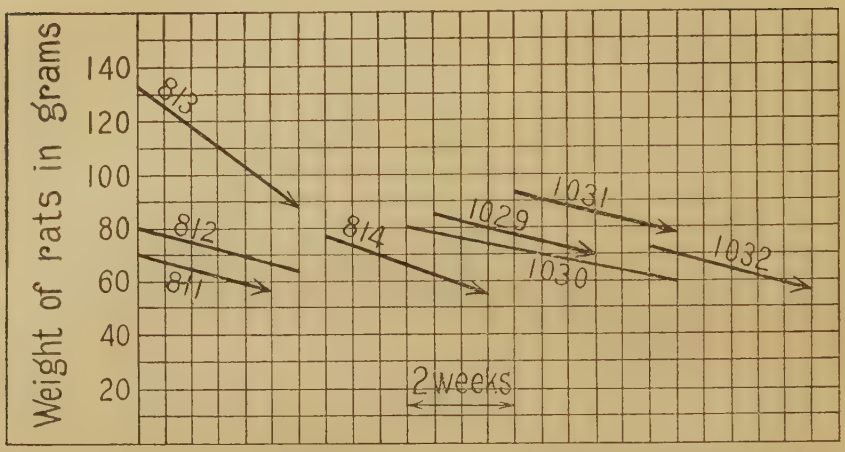

FIG. 32. Sixty per cent of hao tzu kan in the diet did not protect albino rats from beriberi. The high concentration of this food in the diet did not seem to agree with the rats. They did not seem to have normal appetites.

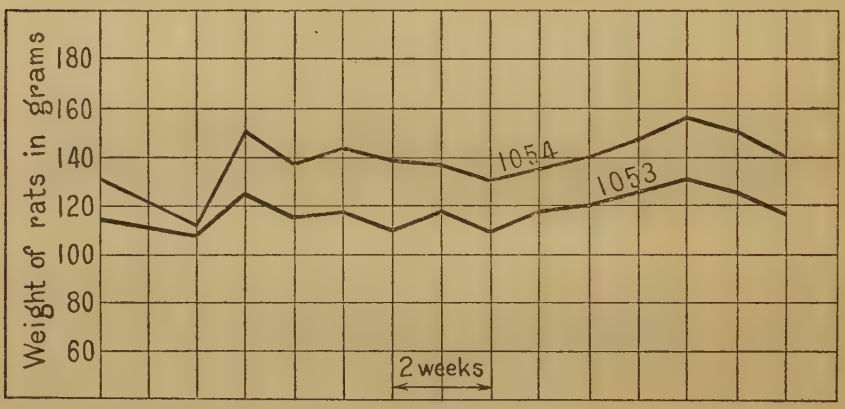

FIG. 33. Forty per cent of p'ieh lan in the basal diet contained enough vitamin B to protect two albino rats from beriberi for fourteen weeks. The rate of growth was subnormal, however.

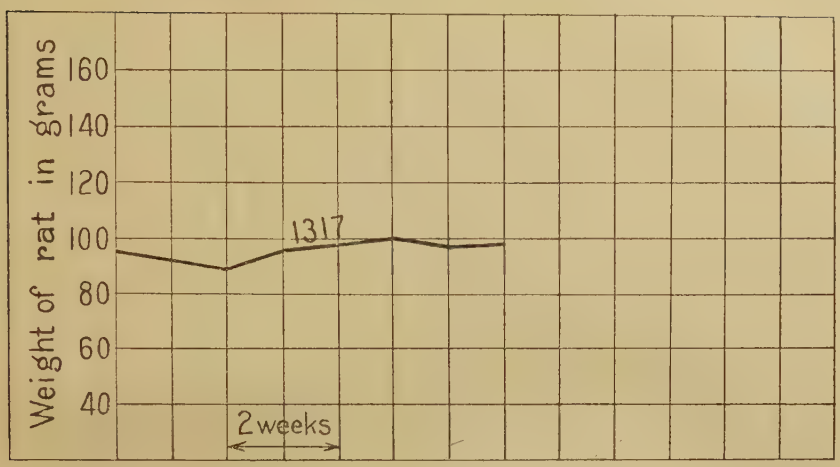

FIG. 34. This rat received 60 per cent of p'ieh lan and 15 per cent of yeast incorporated in the basal diet by eliminating the starch. The growth remained subnormal, thus proving that p'ieh lan when given in great concentration in an otherwise complete diet has a depressing effect on growth.

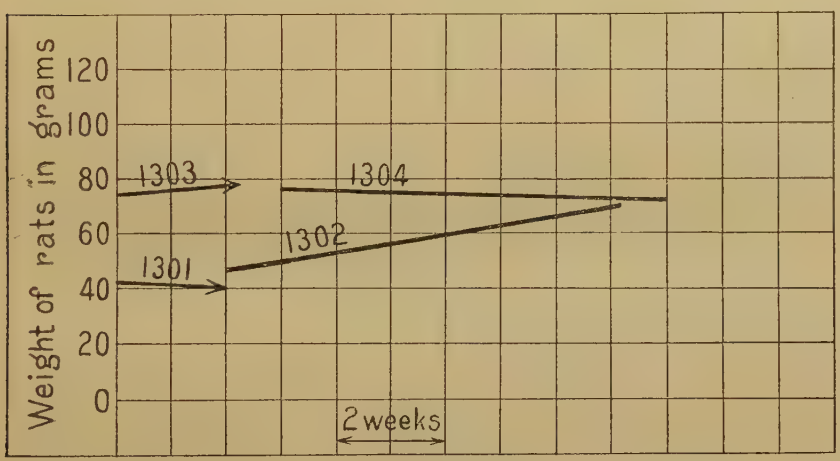

FIG. 35. When 73 per cent of tung kua was incorporated in the basal diet, two of the rats died.

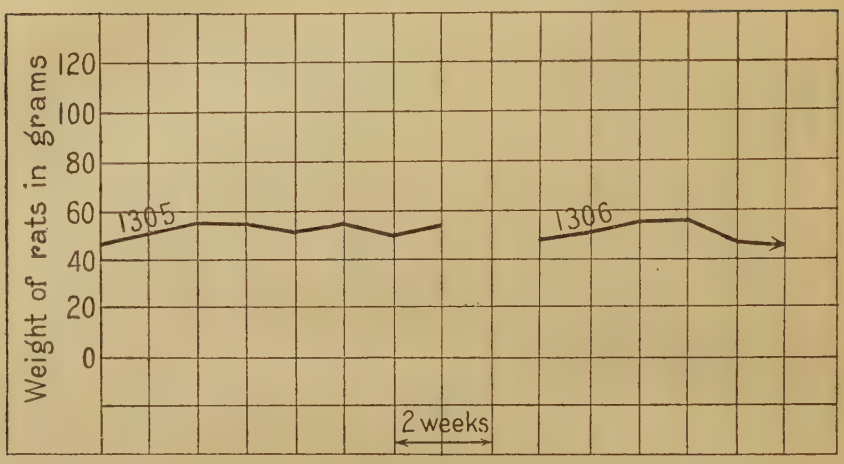

FIG. 36. Fifty-eight per cent of tung kua and 15 per cent of yeast were incorporated in the basal diet of omitting the starch. One rat died and the other rat on this diet showed subnormal growth. These results show that tung kua apparently contains something that hinders the growth when it is given in great concentrations, even with complete diet. At low levels of feeding the rats die of beriberi.

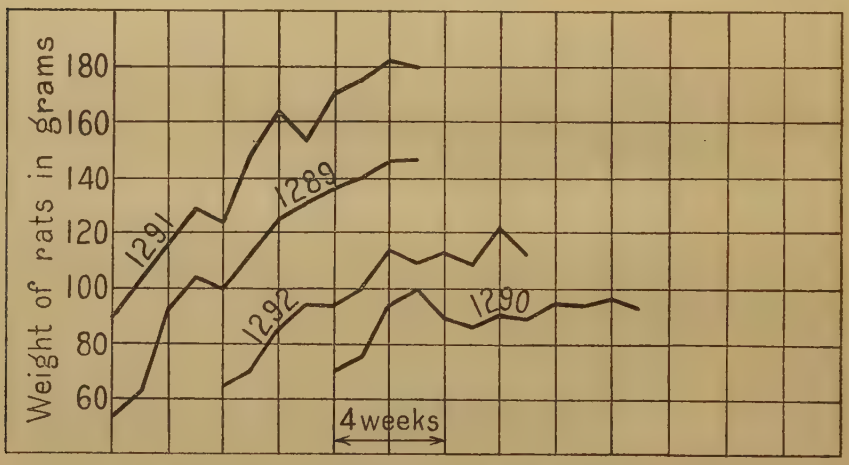

FIG. 37. Ten per cent of kan lu incorporated in the basal diet gave a very good growth. This food is, therefore, an abundant source of vitamin B.

ILLUSTRATIONS

TEXT FIGURES

GROWTH CURVES OF MICE

FIG. 1. These mice received the following basal diet: Casein, 18 per cent; a mixture of salts, 4 per cent; starch, 73 per cent; butter, 5 per cent. All of the mice had beriberi.

2. These mice received the basal diet described under fig. 1 with 15 per cent of ch'ia ts'ai incorporated in the diet by substituting the ch'ia ts'ai for 15 per cent of starch. All of the foods tested were incorporated in the basal diet in the same manner by substitution for an equivalent amount of starch. The second generation on the basal diet and 15 per cent of ch'ia ts'ai showed excellent growth.

3. These mice received the basal diet with 15 per cent of the heads of mung-bean sprouts incorporated in it. This diet was given in order to determine whether the vitamin B content of the sprouts was concentrated more in one part of the plant than in another. The second generation on this diet showed excellent growth.

4. These mice received 15 per cent of yellow soy bean incorporated in the basal diet. The second generation on this diet were having good growth when the experiment was terminated.

5. These mice received 15 per cent of yellow soy-bean sprout incorporated in the basal diet. They showed fair growth and presented no signs of beriberi. Reproduction and growth of the second generation were, however, subnormal when only 15 per cent of yellow soy-bean sprout was used.

6. These mice received 20 per cent of yellow soy-bean sprout incorporated in the diet. They had normal growth and reproduction.

7. These mice were the second generation on a diet of 20 per cent yellow soy bean. They all had normal growth.

8. These mice received 15 per cent of green soy bean incorporated in the basal diet. They showed good growth in the first generation.

9. These mice received 15 per cent of sprouted green soy bean incorporated in the basal diet. The first generation showed almost normal growth, but only two of the second generation survived the period of lactation. When 20 per cent of sprouted green soy bean was given, both the first and the second generations grew normally.

FIG. 10. These mice received 30 per cent of the red variety of kaoliang. Growth was normal, but none of the second generation lived.

11. These mice received 25 per cent of the white variety of kaoliang. Two of the second and three of the third generation lived on this diet. The rate of reproduction was subnormal, however.

12. These mice received 25 per cent of t'zu ku incorporated in the basal diet. They were protected from beriberi and had normal growth. Four of the second generation lived.

13. These mice received 50 per cent of wo kua incorporated in the basal diet. All of the mice were protected from beriberi during the time of the experiment, and the growth of the first generation was almost normal. There was no reproduction on this diet.

14. These mice received 30 per cent of huang hua ts'ai and the basal diet. Growth of the first generation was normal. None of the young lived.

15. These mice received 30 per cent of chieh ts'ai ying and the basal diet. The growth of the first generation was almost normal, but the rate of reproduction was subnormal.

16. These mice were given 40 per cent of hu tzu and the basal diet. The growth of the first generation was almost normal. Reproduction was subnormal.

17. These mice were given the basal diet with 73 per cent of pi ch'i incorporated in it. They all died of beriberi, thus proving that pi ch'i is deficient in vitamin B. Only one mouse lived longer than three weeks.

18. These mice were given the basal diet with 70 per cent of locust seed incorporated in it. They lived from twelve to twenty weeks, but finally died of beriberi, thus proving that while locust seed contains relatively a little more of vitamin B than does pi ch'i both of these foods are deficient in this vitamin.

19. These mice were given 73 per cent of lao mi incorporated in the basal diet. All of them died from beriberi in from two to three weeks.

20. These mice received the basal diet and fresh persimmon ad libitum. They all died from beriberi in from two to seven weeks, thus proving that persimmon is deficient in vitamin B.

21. These mice received the basal diet with 60 per cent of hsiang ch'un incorporated in it. There is evidently a toxic principle in hsiang ch'un which causes convulsions and death after a couple of weeks of a diet containing a high level of hsiang ch'un. The mice died from the effects of a poison, and not from the usual beriberi symptoms. This toxin should be investigated further.

22. These mice received 60 per cent of wo sun in the basal diet. They lost weight and lived only from six to eight weeks.

FIG. 23. These mice received 50 per cent of ssu kua incorporated in the basal diet. Four of the mice were living after eight weeks on this diet. Their growth was subnormal. The results show the presence of vitamin B, but in relatively small amounts.

GROWTH CURVES OF RATS

FIG. 24. A diet of hsiang ch'un, 63 per cent; casein, 18 per cent; a mixture of salts, 4 per cent; butter, 5 per cent; and yeast, 10 per cent was given to albino rats. These rats died after having convulsions, thus confirming the results obtained with mice, and proving the toxic effect of hsiang ch'un even with a diet affording ample vitamin B.

25. These albino rats received 40 per cent of weng ts'ai incorporated in the basal diet. This amount of food supplied enough vitamin B to protect the rats from beriberi, but not enough to insure normal growth and reproduction.

26. Twenty-five per cent of Philippine upo in the basal diet gave good growth and a fair rate of reproduction in the case of three albino rats. This result proves that upo is a plentiful source of vitamin B.

27. Fifty-five per cent of chico protected four albino rats from beriberi for a period of ten weeks.

28. Twenty-five per cent of papaya protected two albino rats from beriberi for a period of ten weeks, but growth was not normal.

29. Thirty-five per cent of papaya in the basal diet gave excellent growth.

30. Twenty per cent of commercial bean curd made from yellow soy bean protected four albino rats from beriberi for twenty-two weeks. This result shows that most of the vitamin B content of the original yellow soy bean appears in the commercial bean curd. This fact should be of practical value, since bean curd and rice often constitute the entire meal of poor Chinese.

31. Sixty per cent of hsi hu lu in the basal diet protected two albino rats from beriberi for fourteen weeks. This result proves the presence of vitamin B in this food, but only in small amount.

32. Sixty per cent of hao tzu kan in the diet did not protect albino rats from beriberi. The high concentration of this food in the diet did not seem to agree with the rats. They did not appear to have normal appetites.

33. Forty per cent of p'ieh lan in the basal diet contained enough vitamin B to protect two albino rats from beriberi for fourteen weeks. The rate of growth was subnormal, however.

34. This rat received 60 per cent of p'ieh lan and 15 per cent of yeast incorporated in the basal diet by eliminating the starch. The growth remained subnormal, thus proving that p'ieh lan when given in great concentration in an otherwise complete diet has a depressing effect on growth.

FIG. 35. When 73 per cent of tung kua was incorporated in the basal diet, two of the rats died.

36. Fifty-eight per cent of tung kua and 15 per cent of yeast were incorporated in the basal diet by omitting the starch. One rat died, and the other rat on this diet showed subnormal growth. These results show that tung kua apparently contains something that hinders the growth when it is given in great concentrations, even with a complete diet. At low levels of feeding the rats die of beriberi. On account of lack of time we were unable to check this work, or to find out whether this food had become contaminated in any way. We hope to repeat this work later and to continue our investigation along these lines.

37. Ten per cent of kan lu incorporated in the basal diet gave very good growth. This food is, therefore, an abundant source of vitamin B.

RELATIVE WATER-SOLUBLE VITAMIN C CONTENT OF NINE ORIENTAL FRUITS AND VEGETABLES

By Hartley Embrey Sherman

Of the Laboratories of Food Chemistry, Peking Union Medical College Peking, China, and the Bureau of Science, Manila[1]

TEN TEXT FIGURES

Many infants in the Orient are fed only preserved, condensed, or powdered milk. With the object of discovering what native foods might be used to protect children in the Orient from scurvy, a control basal diet lacking vitamin C[2] was fed to guinea pigs; many oriental vegetables and fruits were thus tested. Some of the results have already been published.[3] Table 1 gives the results with nine foods.

In each case the stated amount of the fresh food was fed by hand to the guinea pigs before the basal diet (ad libitum) was given. In some cases the fresh food was given in its natural state, and in other cases the freshly expressed juice was used—according to the nature of the food and the ease of feeding. The animals that died during the experiment were examined post mortem for the clinical symptoms of scurvy in guinea pigs.[4]

CONCLUSIONS

Pomegranate, Chinese cabbage, and hsiang ts'ai (*Coriandrum sativum* Linnæus) are rich in vitamin C.

Hung kuo, pich'i (*Eleocharis tuberosa* Naves), and ou (*Nelumbium speciosum* Willdenow) are good sources of vitamin C.

P'ieh lan (probably *Brassica oleracea caulorapa*) contains only a small amount of vitamin C.

Hung tsao (probably *Polygonum orientale* Linnæus) and wo sun (a variety of *Lactuca sativa* Linnæus) are very low in vitamin C.

[1] Most of the laboratory work described in this experiment was done at the Peking Union Medical College, with the aid of my assistant, Mr. Tsan Ch'ing Wang, to whom much credit is due.

[2] Hess, Alfred F., Journ. Ind. Eng. Chem. 13 (1921) 1115.

[3] Embrey, Hartley, Philip. Journ. Sci. 22 (1923) 77.

[4] Jackson, Leila, and J. J. Moore, Journ. Inf. Dis. 19 (1916) 478.

TABLE 1.—*Showing the results of feeding certain fruits and vegetables to guinea pigs.*

English name or description of the food tested.	Local name in Peking dialect and, when possible, in Tagalog.	Scientific name.	Minimum amount of food protecting from scurvy.	Remarks.
A green leaf	Hsiang ts'ai (Chinese); onsoy or huan suy (Filipino).	*Coriandrum sativum* Linnæus	Five grams daily	A rich source of vitamin C; 4 grams daily protected two pigs for twenty-four weeks. Other pigs on 4 grams died from scurvy.
A small red fruit common in Peking.	Hung kuo		The juice expressed from 10 grams of the fruit given daily.	A good source of vitamin C.
A tuber called by Americans "water chestnut."	Pi ch'i	*Eleocharis tuberosa* Naves	Ten cubic centimeters daily of juice expressed from the tuber.	Do.
Pomegranate	An shih liu	*Punica granatum* Linnæus	Five cubic centimeters daily of juice expressed from the fruit.	A rich source of vitamin C.
Chinese cabbage	Pai ts'ai		Three grams daily	Do.
Apparently a kind of kohlrabi.	P'ieh lan	Probably *Brassica oleracca caulorapa* or *Brassica campestris* Linnæus.	Fifteen cubic centimeters daily of juice expressed from the vegetable.	Contains a fair amount of vitamin C. One guinea pig was protected on this amount. Several guinea pigs died from scurvy.
A lettuce root	Wo sun	Variety of *Lactuca sativa* Linnæus.	Thirty cubic centimeters daily of juice expressed from this food did not afford protection.	Animals refused to take more than 30 cubic centimeters. Deficient in vitamin C.
	Hung tsao	Probably *Polygonum orientale* Linnæus.	Juice expressed from 30 grams given daily did not afford protection.	Deficient in vitamin C.
Lotus root, an esteemed Chinese vegetable.	Ou (Chinese); baino (Filipino)	*Nelumbium speciosum* Willdenow.	Ten cubic centimeters daily of juice expressed from the lotus root.	A good source of vitamin C.

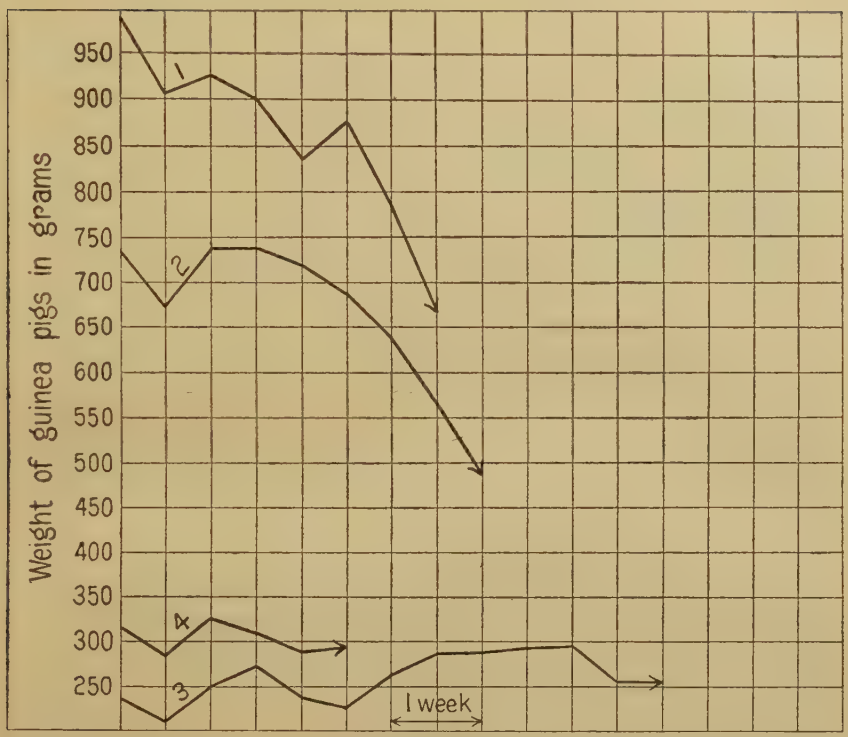

FIG. 1. Guinea pigs 1, 2, 3, and 4. These pigs received the following basal diet: Whole wheat, 86 per cent; yeast, 2 per cent; wheat bran, 3 per cent; butter, 3 per cent; calcium lactate, 3 per cent; sodium choloride, 3 per cent. In addition, 30 cubic centimeters of whole milk, previously boiled for forty-five minutes, were given daily. The animals given this basal diet were purposely chosen with entirely different initial weights, but in each case the animal died from scurvy.

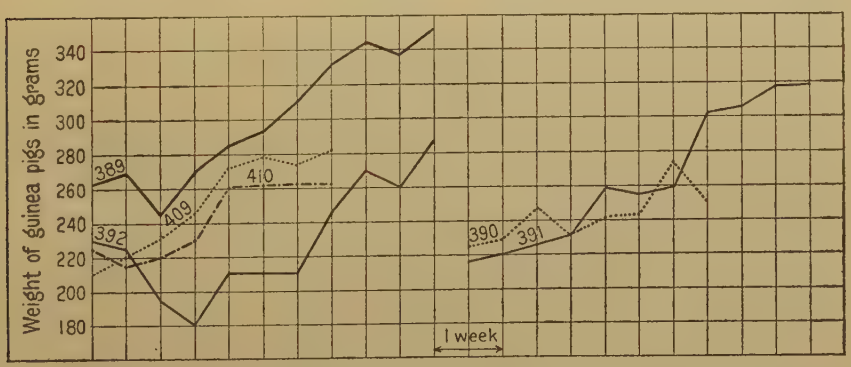

FIG. 2. Guinea pigs 389, 390, 391, 392, 409, and 410 received the basal diet and in addition 5 grams of hsiang ts'ai daily. All were protected from scurvy during the period of experimentation.

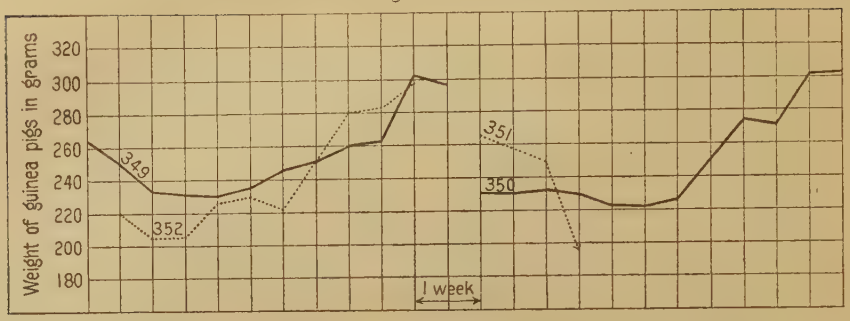

FIG. 3. Guinea pigs 349, 350, 351, and 352 received the basal diet and in addition the juice expressed from 10 grams of hung kuo daily. Pig 351 died from pneumonia. The other pigs were protected from scurvy during the period of experimentation.

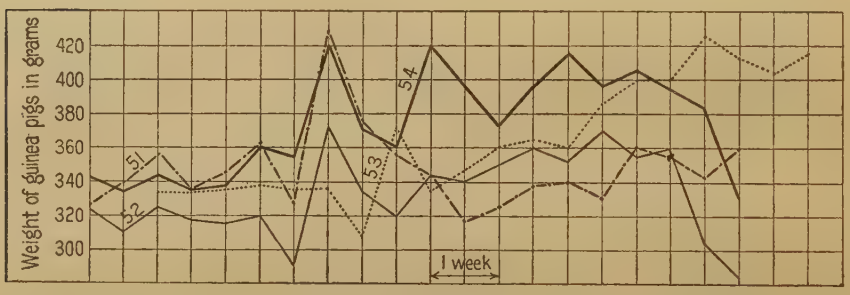

FIG. 4. Guinea pigs 51, 52, 53, and 54 received the basal diet and in addition 10 cubic centimeters of pi ch'i juice daily. All of the animals were protected from scurvy with the exception of pig 52 which died from scurvy after nine weeks of this diet.

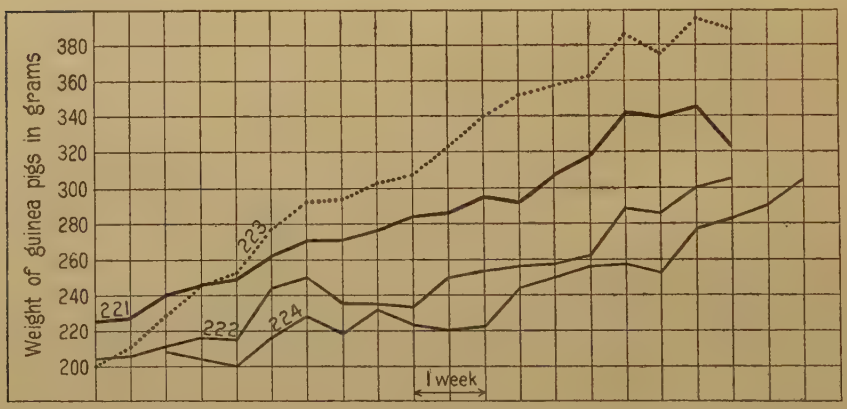

FIG. 5. Guinea pigs 221, 222, 223, and 224 received the basal diet and in addition 5 cubic centimeters of pomegranate juice daily. All of the animals on this diet were protected from scurvy for a period of nine weeks.

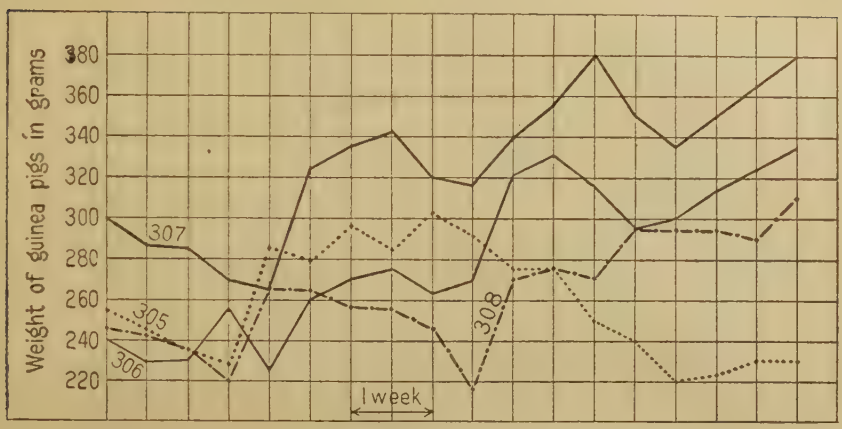

FIG. 6. Guinea pigs 305, 306, 307, and 308 received the basal diet and in addition 3 grams of pai ts'ai, or Chinese cabbage, daily. All of the pigs were protected from scurvy for a period of more than eight weeks.

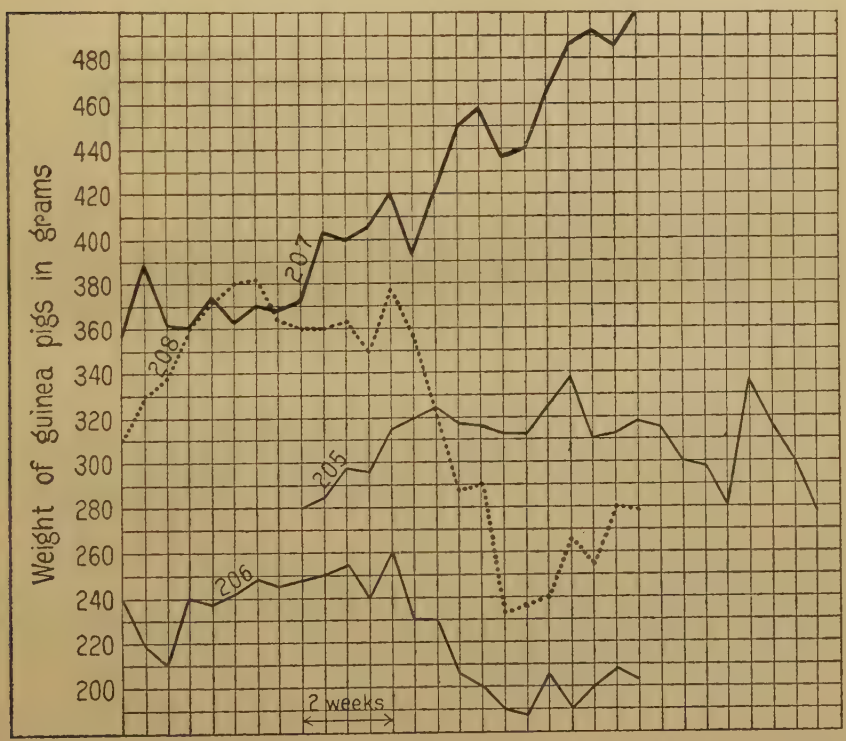

FIG. 7. Guinea pigs 205, 206, 207, and 208 received the basal diet and in addition 15 cubic centimeters of the juice of p'ieh lan daily. All except pig 206 were protected from scurvy for a period of twelve weeks, but only one attained normal weight.

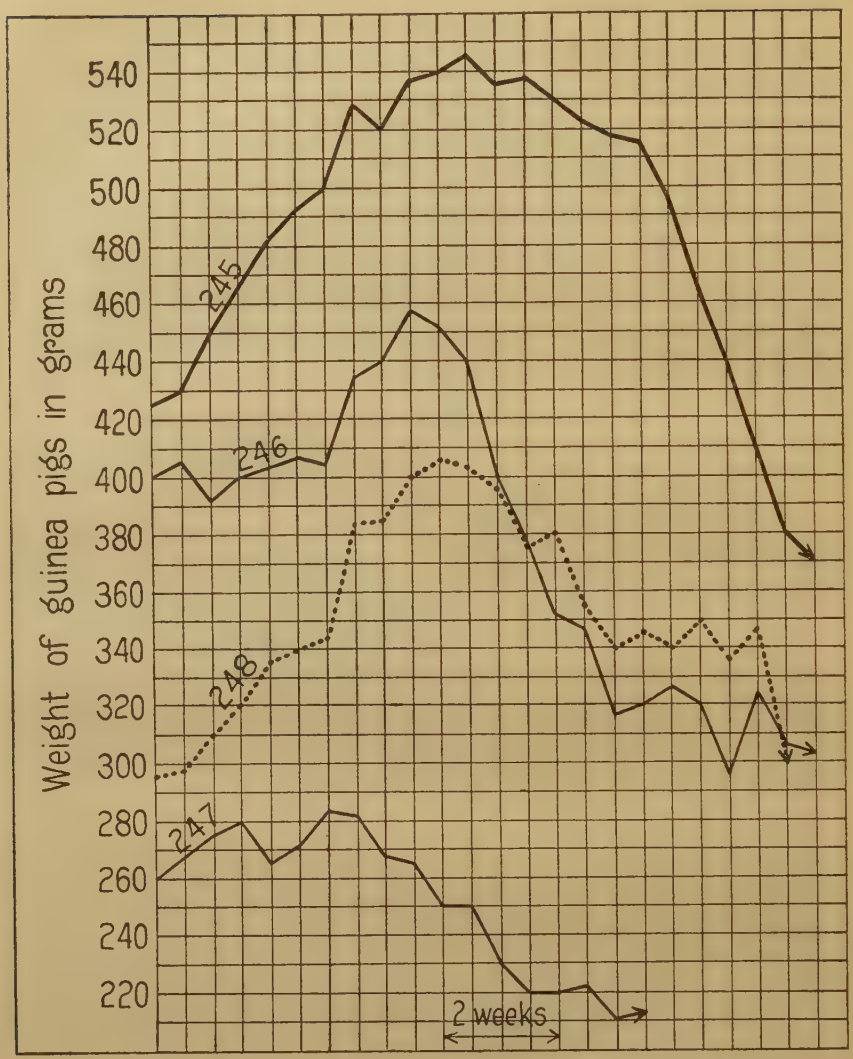

FIG. 8. Guinea pigs 245, 246, 247, and 248 received the basal diet and 30 cubic centimeters of juice expressed from wo sun daily. This amount of wo sun did not protect from scurvy and all of the pigs died. They could not be induced to take more than 30 cubic centimeters of wo sun. We succeeded in making them take the 30 cubic centimeters mentioned by feeding small amounts only, at spaced intervals during the day. The pigs lived from eight to ten weeks.

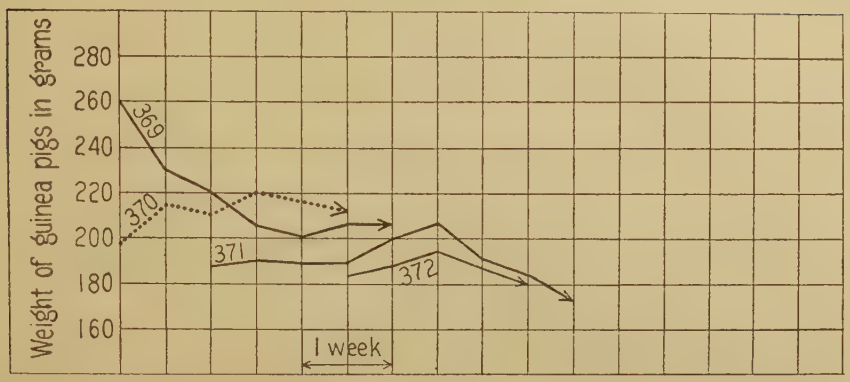

FIG. 9. Guinea pigs 369, 370, 371, and 372 received the basal diet and in addition the juice expressed from 30 grams of hung tsao daily. All of the pigs died from scurvy in from three to four weeks.

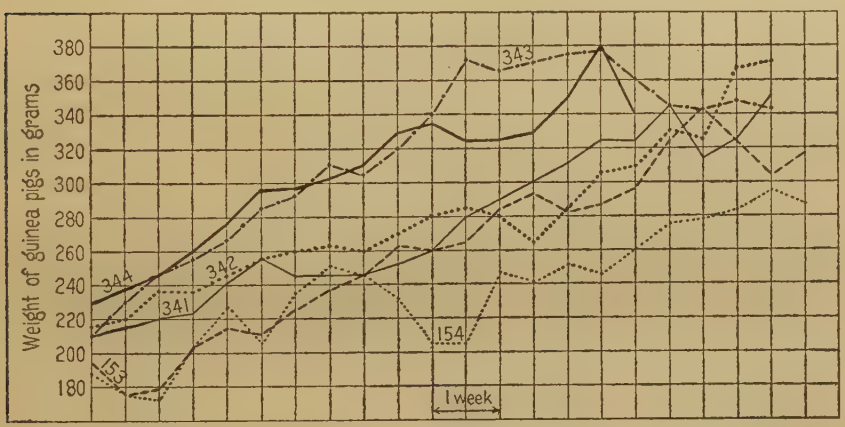

FIG. 10. Guinea pigs 341, 342, 343, 344, 153, and 154 received the basal diet and in addition 10 cubic centimeters of lotus root (ou) juice daily. All were protected from scurvy for a period of ten weeks. Pig 344 died from pneumonia, but post-mortem examination showed also a slight tendency toward scurvy.

ILLUSTRATIONS

TEXT FIGURES

[The numbers above the growth curves are the identification numbers of the animals; the weights of the guinea pigs are shown by the figures on the axes of ordinates; the number of weeks of experimentation is indicated by the numbers on the axes of abscissæ. An arrowhead terminating the growth curve indicates the death of the animal in question. Omission of the arrowhead indicates that the animal was still living at the end of the experiment.]

take the 30 cubic centimeters mentioned by feeding small amounts only, at spaced intervals during the day. The pigs lived from eight to ten weeks.

FIG. 9. Guinea pigs 369, 370, 371, and 372 received the basal diet and in addition the juice expressed from 30 grams of hung tsao daily. All of the pigs died from scurvy in from three to four weeks.

10. Guinea pigs 341, 342, 343, 344, 153, and 154 received the basal diet and in addition 10 cubic centimeters of lotus root (*ou*) juice daily. All were protected from scurvy for a period of ten weeks. Pig 344 died from pneumonia, but post-mortem examination showed also a slight tendency toward scurvy.

CERTAIN PROTEINS ADDED TO MUNG BEAN, OR TO WHITE OR RED SORGHUM VULGARE, INCREASE THE FERTILITY OF MICE

By Hartley Embrey Sherman

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TWENTY-SIX TEXT FIGURES

In an article published in 1921,(1) the author proved that the proteins of mung bean were biologically complete, since all the first generation of Chinese white mice grew to normal weight when the mung bean, *Phaseolus aureus* Roxburgh, was used as the sole source of protein. In the same article attention was drawn to the fact that the diet of chart 3 (mung bean, 89.3 per cent; salt mixture, 3.7 per cent; dextrin, 2 per cent; and butter, 5 per cent) gave decidedly subnormal reproduction, and none of the second generation lived through the period of lactation. Charts 6 and 7 of the same article showed that the substitution of 5 and 8 per cent, respectively, of casein for the same amount of mung bean increased the fertility and also the number of young that could be successfully raised on that diet.

Chart 21 of the same article showed that a diet consisting of red kaoliang (a red variety of kaoliang, scientifically known as *Sorghum vulgare*), 91.3 per cent; a mixture of salts, 3.7 per cent; and butter, 5 per cent, gave subnormal growth in the first generation. The reproduction rate was very low, and none of the second generation survived.

Chart 22 of the same article showed that the substitution of 9 per cent of casein in the diet of chart 21 for the same amount of red kaoling improved the growth of mice of the first generation, and increased their fertility and their rate of reproduction, but none of the second generation lived beyond the period of lactation.

[1] Thanks are due to Mr. Tsan Ch'ing Wang, my assistant in the Peking Union Medical College, for technical help and coöperation in all of the laboratory work done in China.

Chart 27 of the same article showed that a diet of white unpolished kaoliang (the white variety of *Sorghum vulgare*), 91.3 per cent; a mixture of salts, 3.7 per cent; and butter, 5 per cent, gave almost normal growth in the first generation, but reproduction was subnormal and none of the second generation lived.

Chart 28 of the same article showed that lowering the amount of white kaoliang to 45 per cent and adding 9 per cent of casein to the diet in chart 27 gave normal growth in the first generation. The rate of reproduction was improved, and five individuals of the second generation grew to normal weight on this diet.

To sum up the results previously reported, both mung bean and white kaoliang gave good growth in the first generation and red kaoliang gave fair growth in the first generation; but each of these food substances, when used alone as the sole source of protein, failed to give normal birth rates and also failed to nourish the mother mice adequately, so that the few mice that were born on this diet did not live through the period of lactation.

It was not surprising, therefore, that Maxwell, reasoning by analogy from the sterility results showed by my mice on the above and other similar diets, found that many cases of apparent pregnancy toxæmia in humans were due merely to food deficiency.(2)

In view of the fact that mung bean and white and red kaoliang are among the main cheap food substances found in North China, and, consequently, are used as the sole sources of protein in the diets of thousands of the poorer Chinese, it seemed important to us to find out what other cheap foods, also native to North China, could be added to mung bean and to red and to white kaoliang, in order to increase the fertility of the first generation, to enable the young to live through the period of lactation, and to attain normal growth in the second generation.

The experiments reported in this paper were conducted before July, 1923, but remained unpublished until the present time. They should be of interest as preceding the subsequent work done by various workers on vitamin E, and the results reported here should also have a special practical value in formulating cheap diets of native foods suitable for hospitals, schools, and other public institutions in the Orient.

The proteins selected to be tested for their effects as supplements to mung bean and to white and to red kaoliang were

peanuts, after the fat had been extracted with ether; soy bean, after the fat had been extracted with ether; gelatine; egg white; and casein. These proteins were all chosen on account of their cheapness and, with the exception of casein, on account also of their being found in abundance almost everywhere in the Orient. The peanut press cake and the soy-bean press cake are especially cheap; but, unfortunately, since they have been used very little in the past for human food, they often are found in the market in a filthy condition, fermenting, and strong with the odor and taste of rancid oils. Therefore, I used in these experiments only the clean foods prepared in the laboratory after the oils had been removed by extraction with ether. The substances remaining after extraction resembled the commercial press cake from a chemical point of view only, but they did not have any of the deleterious effects which might have resulted from the use of dirty, rancid, fermenting press cake. In feeding on a large scale, if clean press cake cannot be bought, the cheapness of the original peanut and soy bean will warrant their being used as supplementary foods.

EXPERIMENTAL METHODS

As far as possible we used the technic of Osborne and Mendel. Our standard salt mixture consisted of sodium chloride, 0.173 gram; magnesium sulphate, 0.266 gram; sodium dihydrogen phosphate, 0.347 gram; potassium monohydrogen phosphate, 0.954 gram; soluble calcium phosphate, 0.540 gram; ferric citrate, 0.118 gram; and calcium lactate, 1.300 grams.

Butter was melted below 45° C. and the clear liquid decanted and centrifuged for an hour.

The Chinese foods investigated were cooked for forty minutes in an autoclave at 15 pounds pressure, and dried in a current of air below 60° C. The ingredients used in our diets were ground so fine that the animals were unable to separate them. The food mixtures had the percentage composition shown in the graphs, and were given ad libitum.

In all of the feeding work reported in this paper, Chinese white mice were used as experimental animals. Their growth curves were compared to the standard growth curves reported in chart 1 in a previously published article.(1) White mice were used because we were unable to secure white albino rats at the time that the experimental work described in this article was being done.

FIG. 1. These curves represent, 1, the average of ten growth curves made from female mice and, 2, the average of ten growth curves made from male mice. The diet was given in three separate containers ad libitum. The first had a homogeneous mixture of yellow soy bean, 45 per cent; casein, 3 per cent; butter, 5 per cent; salt mixture, 3 per cent; and dextrin, 44 per cent. The second container had fresh cabbage or spinach. The third had either fresh milk or mashed hard-boiled egg. During this experiment forty young were born to the ten pairs of mice. More than thirty of the mice of the second generation lived and attained normal weight. The curves in fig. 1, of the animals receiving this liberal diet, were taken as our standard growth curves.

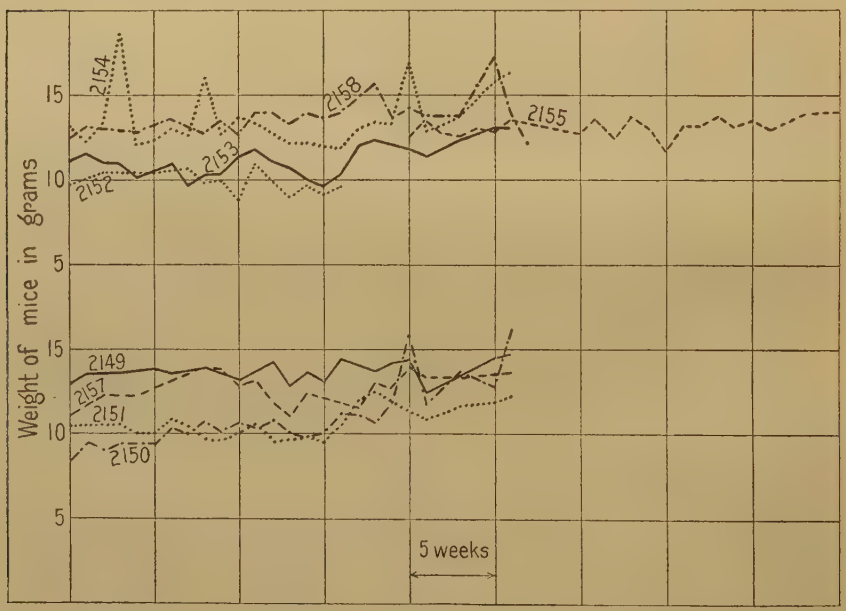


FIG. 2. These curves show the growth of the first generation of mice receiving the following diet: Mung bean, 84.3 per cent; a mixture of salts, 3.7 per cent; starch, 2 per cent; butter, 5 per cent; peanut, previously extracted with ether, 5 per cent. Growth was normal.

FIG. 3. These curves represent the growth of the second generation of mice on the diet that was fed to the animals whose growth is recorded in fig. 2. Five typical curves only are shown, although ten young lived and grew to normal weight.

SUMMARY OF EXPERIMENTAL WORK

1. When mung bean (*Phaseolus aureus* Roxburgh) was used as the sole source of protein in the diet of Chinese white mice, the first generation showed normal growth, thus proving that the proteins must be biologically complete. Reproduction, however, was subnormal, and none of the second generation survived the period of lactation. The addition of small quantities of casein improved the birth rate.(1)

Five per cent of fat-free peanut, added to the mung-bean diet by substituting it for the equivalent amount of the mung bean, raised the rate of reproduction to about three-fourths normal. The second and the third generation on this diet showed good growth.

2. Five per cent of gelatine, added to the mung-bean diet by replacing the equivalent amount of mung bean, raised the rate of reproduction to about three-fourths normal. All of the second generation grew to normal weight.

3. Five per cent of egg white, added to the mung-bean diet by replacing the equivalent amount of mung bean, improved the rate of reproduction to about one-fourth normal. The second generation on this diet grew to almost normal weight.

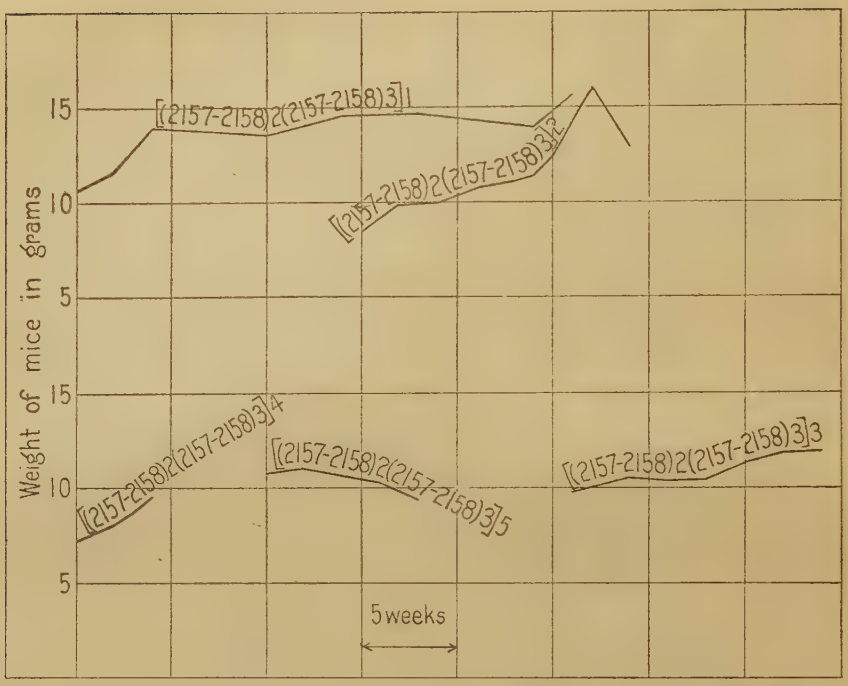


FIG. 4. These curves show the growth of the third generation on the diet that was fed to the animals whose growth is recorded in fig. 2. Inspection of figs. 2, 3, and 4 shows that the rate of reproduction was greatly improved by the addition of 5 per cent of peanut. Ten of the second generation lived and grew to normal weight. The growth of the second and the third generation on this diet was normal.

4. Five per cent of fat-free soy bean, added to the mung-bean diet by replacing an equivalent amount of mung bean, improved the rate of reproduction slightly. Two of the second generation lived, and one of them attained normal weight.

5. When white kaoliang (a Chinese variety of white edible sorghum, scientifically known as *Sorghum vulgare*) was used as the sole source of protein in the diet of Chinese white mice, the first generation showed good growth. Reproduction was subnormal, however, and few of the second generation survived the period of lactation. Fifteen per cent of mung bean, added to the white kaoliang diet by replacing an equivalent amount of white kaoliang, raised the birth rate to normal. All of the second and third generations on this diet showed good growth.

6. Five per cent of fat-free soy bean, added to the white kaoliang diet by replacing an equivalent amount of white kaoliang, raised the birth rate to normal. During the time of the experiment all of the second generation showed good growth.

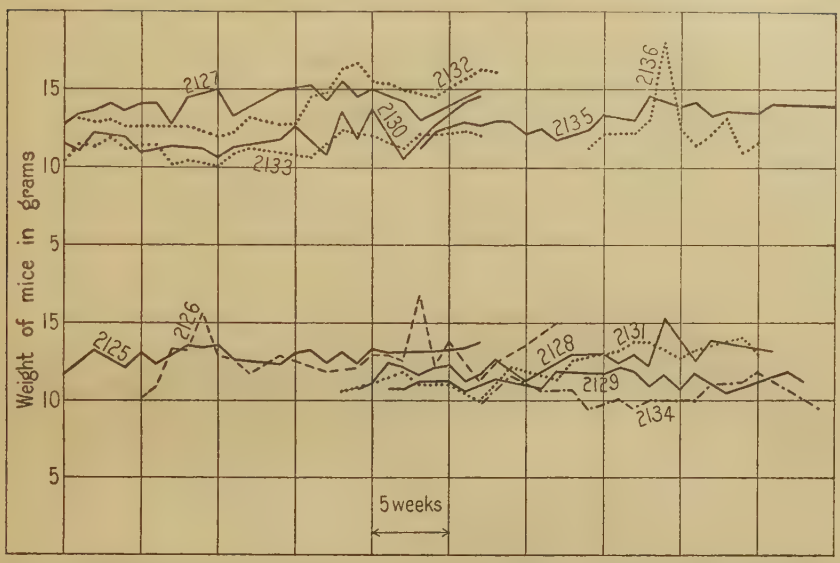


FIG. 5. These curves show the growth of the first generation of mice receiving the following diet: Mung bean, 84.3 per cent; gelatine, 5 per cent; a mixture of salts, 3.7 per cent; starch, 2 per cent; butter, 5 per cent. Growth was normal.

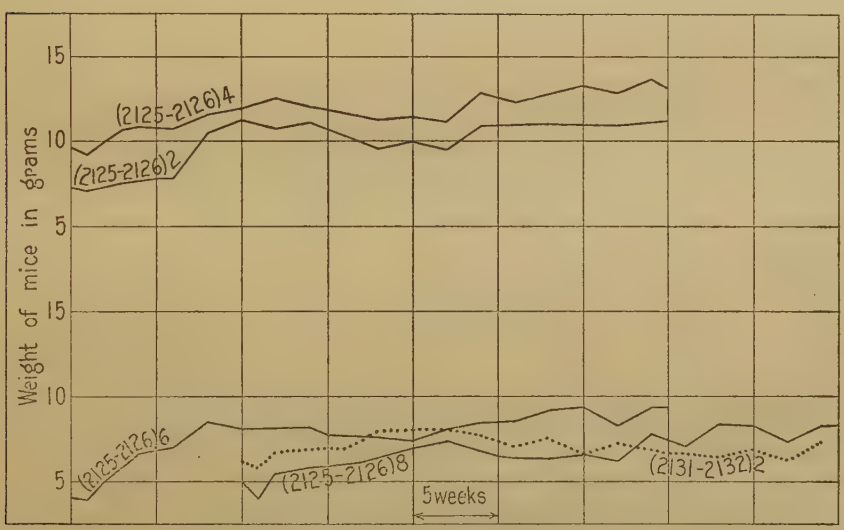


FIG. 6. These curves show the growth of the second generation of mice on the diet that was fed to the animals whose growth is recorded in fig. 5. The addition of 5 per cent of gelatine improved the fertility of the parent mice. The rate of growth of the second generation was normal except in the case of one mouse whose rate of growth was slightly subnormal.

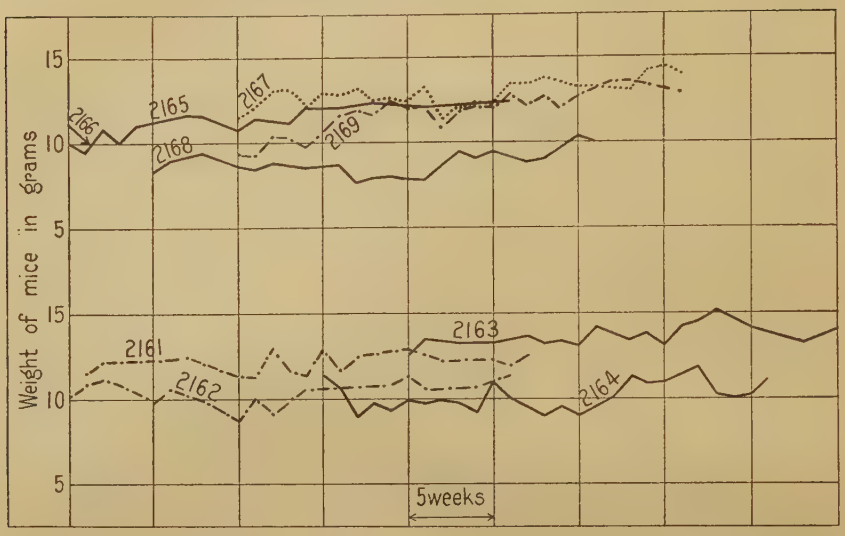


FIG. 7. These curves show the growth of the first generation of white mice on the following diet: Mung bean, 84.3 per cent; soy bean, with the fat removed by previous extraction with ether, 5 per cent; a mixture of salts, 3.7 per cent; starch, 2 per cent; butter, 5 per cent.

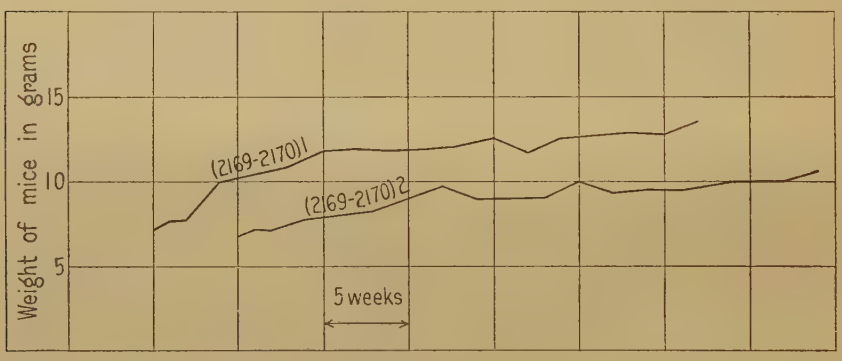


FIG. 8. These curves are for the second generation of mice on the diet that was fed to the animals whose growth is recorded in fig. 7. The rate of reproduction was slightly improved by the addition of 5 per cent of fat-free soy bean. Two of the second generation lived, and one of them reached normal weight.

7. The addition of 5 per cent of fat-free peanut to the white kaoliang diet increased the birth rate to normal. All of the second generation showed good growth on this diet.

8. The addition of 5 per cent of casein to the white kaoliang diet raised the birth rate to almost normal. The second generation on this diet showed good growth.

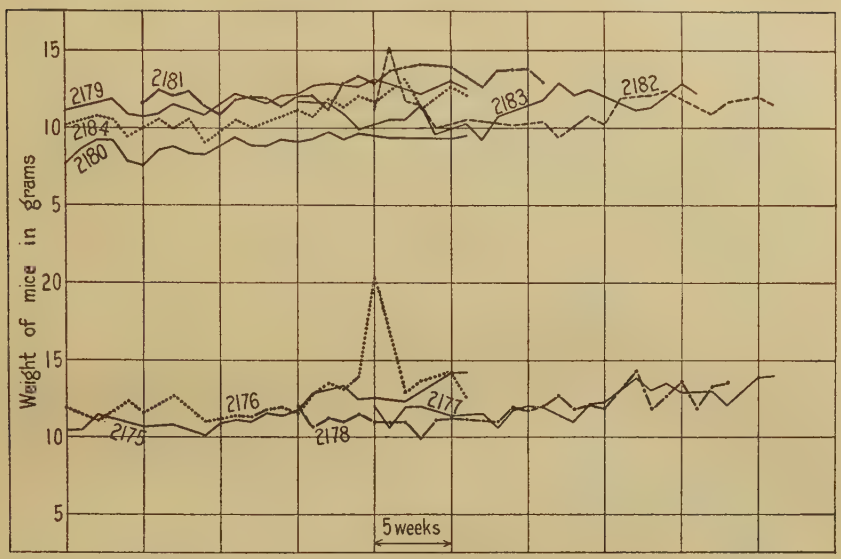


FIG. 9. These curves show the growth of the first generation of mice on the following diet: Mung bean, 92 per cent; sodium chloride and calcium carbonate, 3 per cent; egg white, 5 per cent. All of the first generation showed normal growth except one mouse, whose growth was slightly subnormal.

FIG. 10. These curves show the growth of the second generation of mice on the diet that was fed to the animals whose growth is recorded in fig. 9. The addition of 5 per cent of egg white improved the rate of reproduction.. Four of the young lived, and two of them attained normal growth.

9. A diet of 50 per cent of ordinary millet and 50 per cent of white kaoliang increased the birth rate slightly. Three of the second generation survived and showed good growth.

10. When red kaoliang (the red variety of *Sorghum vulgare*) was used as the sole source of protein in the diet of white

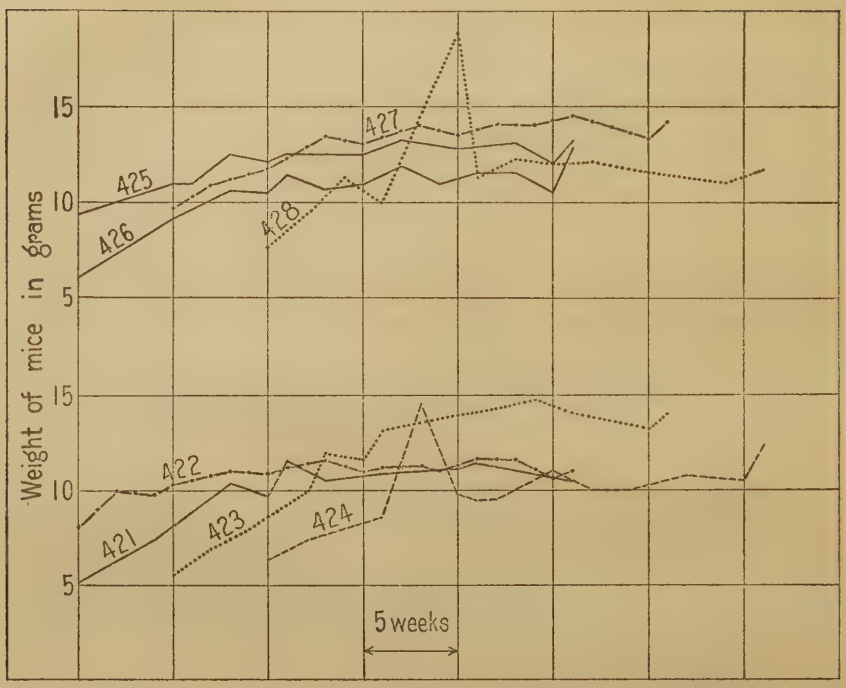


FIG. 11. These curves show the growth of the first generation on the following diet: Red kaoliang, 86 per cent; casein, 5 per cent; a mixture of salts, 4 per cent; butter, 5 per cent. The addition of 5 per cent of casein improved the growth of the first generation on a red kaoliang diet.

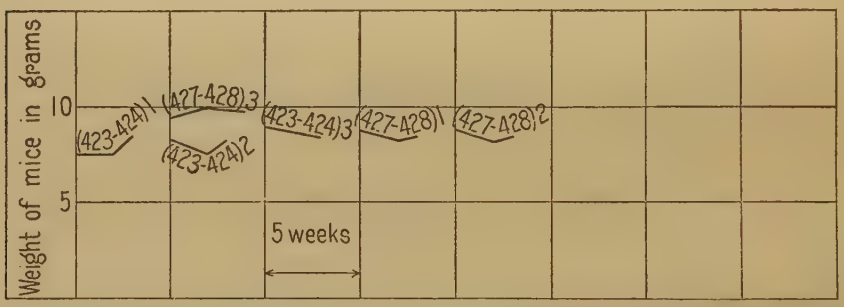


FIG. 12. These curves represent the growth of the second generation of mice on the diet that was fed to the animals whose growth is recorded in fig. 11. While the addition of 5 per cent of casein improved the rate of reproduction, the six young of the second generation that lived seemed not to be gaining normally and the experiment wsa stopped.

Chinese mice, the mice did not attain normal growth in the first generation. Reproduction was subnormal, and none of the second generation survived.(1) When 5 per cent of casein was added to the diet, by substituting it for an equal amount of red kaoliang, the rate of reproduction was improved to almost one-

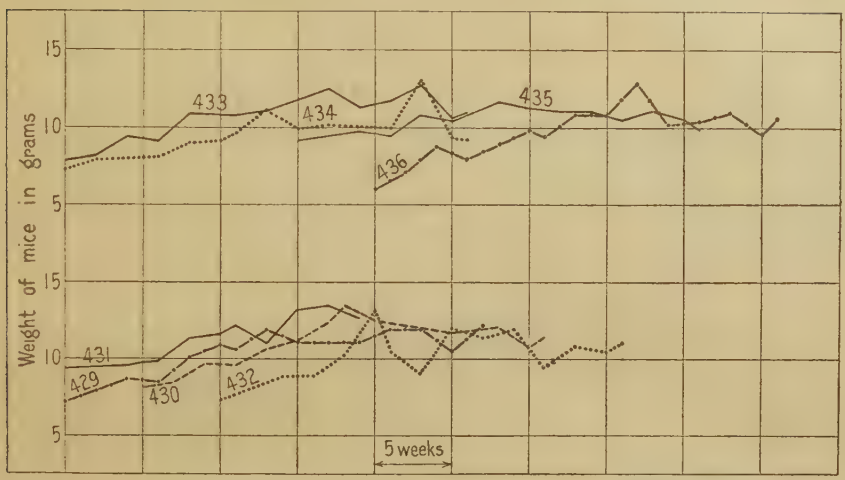


FIG. 13. These growth curves are for the first generation of mice on the following diet: Red kaoliang, 86 per cent; peanut, previously extracted with ether, 5 per cent; a mixture of salts, 4 per cent; butter, 5 per cent. The rate of reproduction was low, and none of the second generation survived.

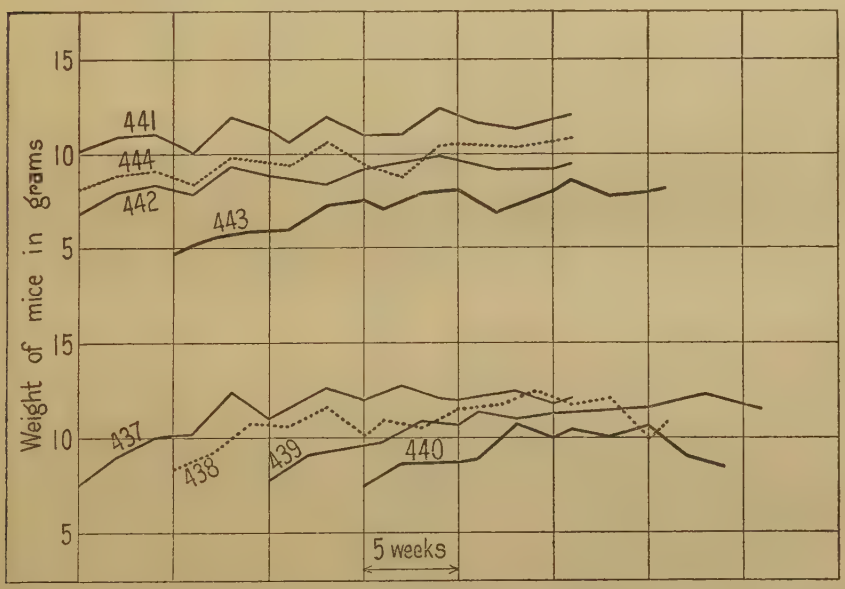


FIG. 14. These curves show the growth of the first generation of mice on the following diet: Red kaoliang, 86 per cent; soy bean, previously extracted with ether, 5 per cent; a mixture of salts, 4 per cent; butter, 5 per cent. This diet produced only one litter of two mice, neither of which lived.

half normal. Six of the second generation lived through the period of lactation. The experiment was terminated at that time.

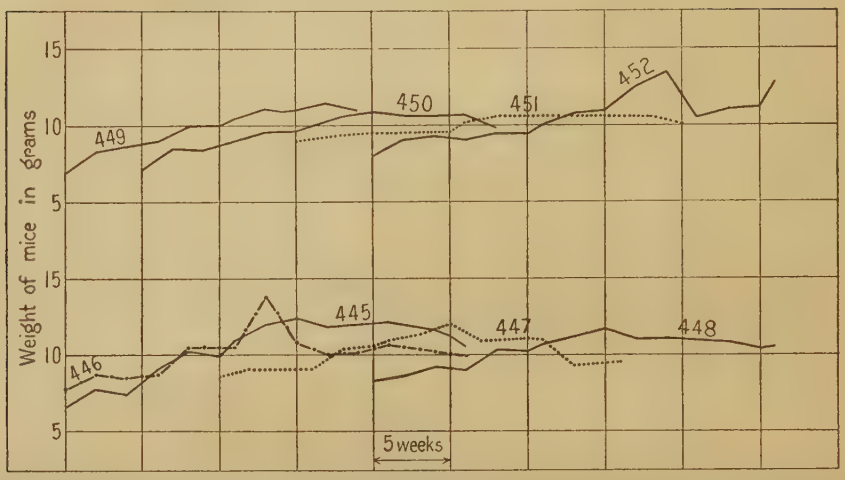


FIG. 15. These curves give the growth of the first generation of mice on the following diet: Red kaoliang, 76 per cent; mung bean, 15 per cent; a mixture of salts, 4 per cent; butter, 5 per cent. Two litters of young were born, but only one mouse lived. Since the growth of this mouse was subnormal the experiment was discontinued.

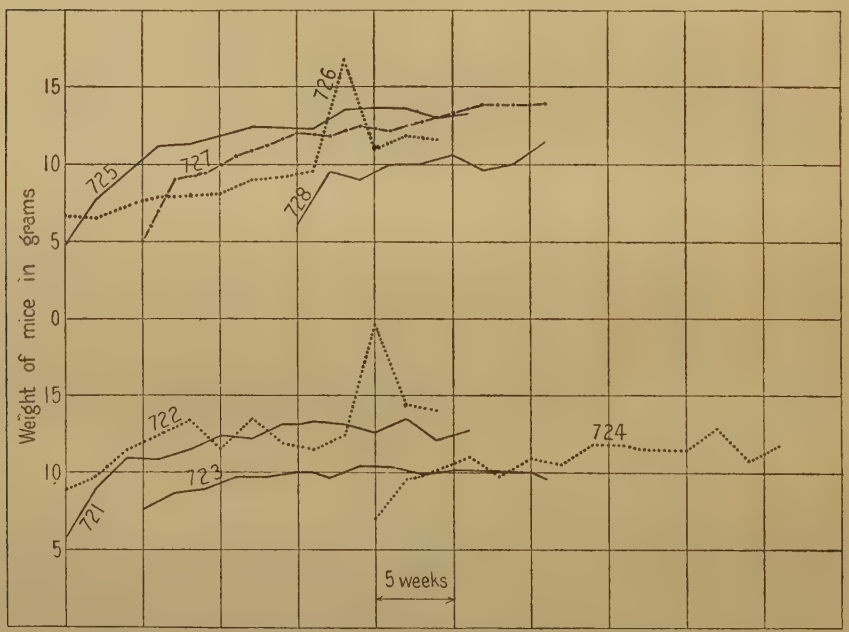


FIG. 16. These curves show the growth of the first generation of white mice on the following diet: White kaoliang, 86 per cent; casein, 5 per cent; a mixture of salts, 4 per cent; butter, 5 per cent. Growth was normal and the reproduction was improved by the addition of 5 per cent of casein.

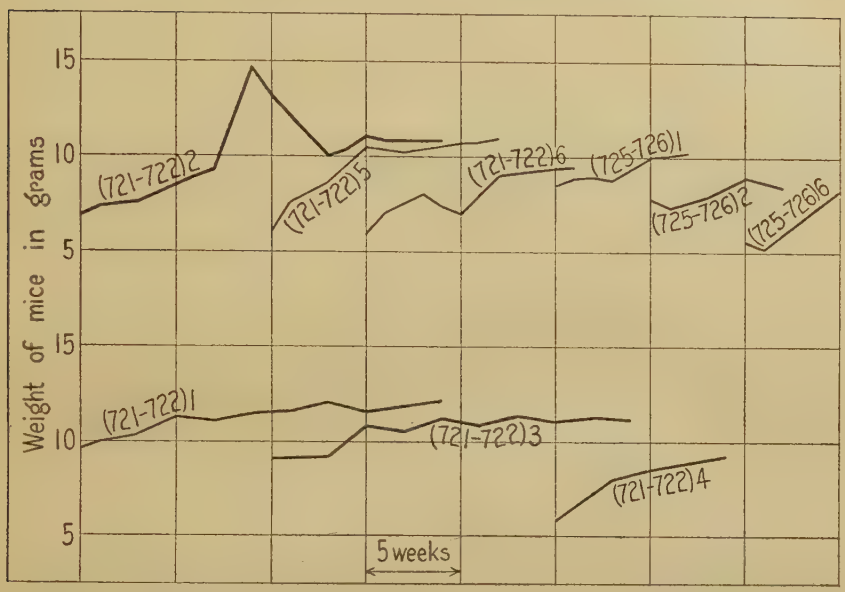


FIG. 17. These curves show the growth of the second generation of mice on the diet that was fed to the animals whose growth is recorded in fig. 16.

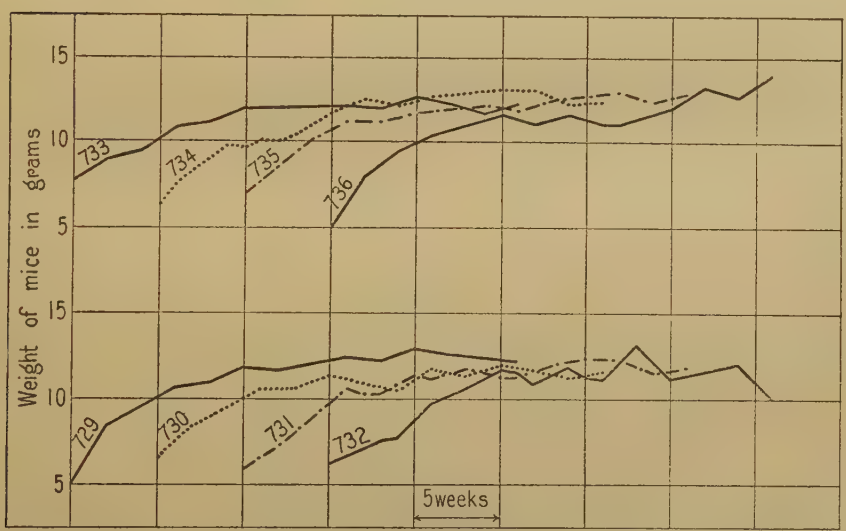


FIG. 18. These curves give the growth of the first generation of mice on the following diet: White kaoliang, 86 per cent; peanut, previously extracted with ether, 5 per cent; a mixture of salts, 4 per cent; butter, 5 per cent. The growth of the first generation was excellent, and reproduction was normal.

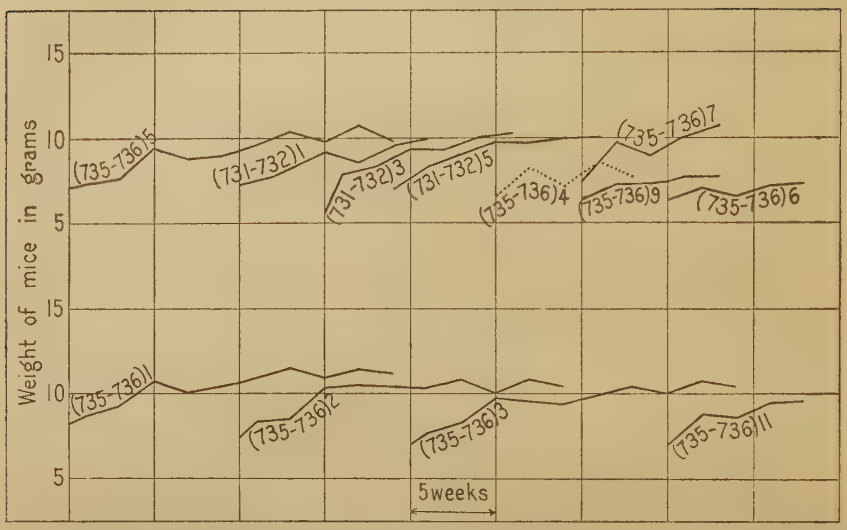
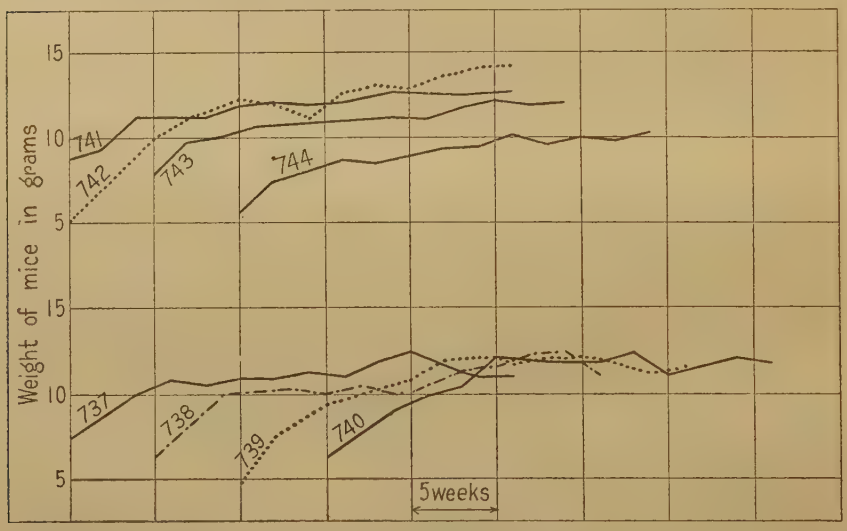


FIG. 19. These curves show the growth of the second generation on the diet that was fed to the animals whose growth is recorded of the young lived through the period of lactation and were showing good growth at the termination of the experiment.



F|7. 20. These curves give the growth of the first generation of mice on a diet of white kaoliang, 86 per cent; soy bean, previously extracted with ether, 5 per cent; a mixture of salts, 4 per cent; and butter, 5 per cent. Growth was excellent except in the case of one mouse. Reproduction was normal.

11. Fifteen per cent of mung bean, added to the diet of red kaoliang by reducing the red kaoliang an equal amount, raised the rate of reproduction slightly. One of the second generation survived the period of lactation.

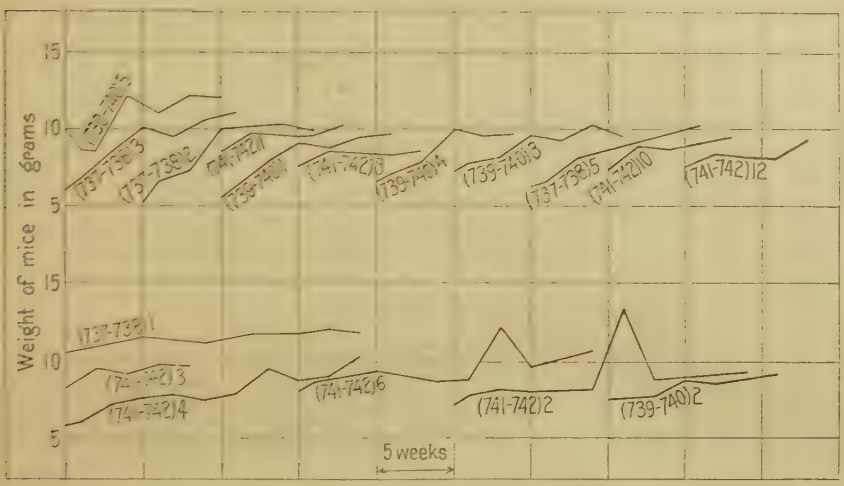


FIG. 21. These curves represent the growth of the second generation on the diet that was fed to the animals whose growth is recorded in fig. 20. All of the young lived through the period of lactation and were showing good subsequent growth at the termination of the experiment. Before the termination of the experiment two litters of the third generation were born. The young of the third generation were showing good growth at the conclusion of the experiment.

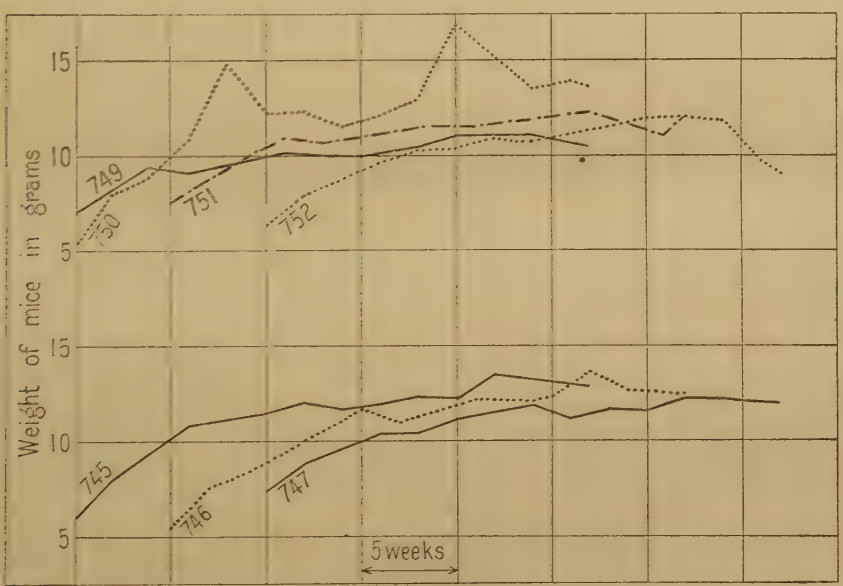


FIG. 22. These curves give the growth of the first generation of mice on a diet of white kaoliang, 76 per cent; mung bean, 15 per cent; a mixture of salts, 4 per cent; and butter, 5 per cent. The growth and the rate of reproduction were normal.

12. Five per cent of fat-free peanut and 5 per cent of fat-free soy bean, added separately to the red kaoliang diet, did not in-

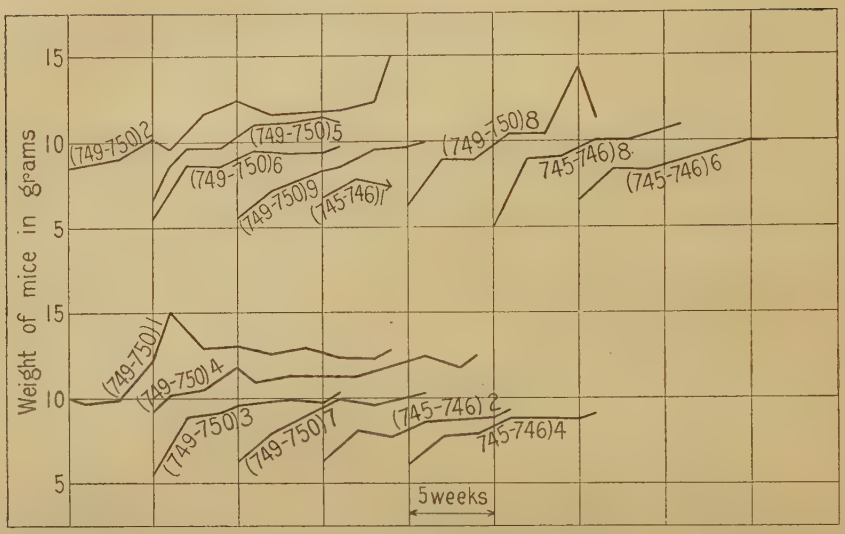


FIG. 23. These curves give the growth of the second generation on the diet that was fed to the animals whose growth is recorded in fig. 22.

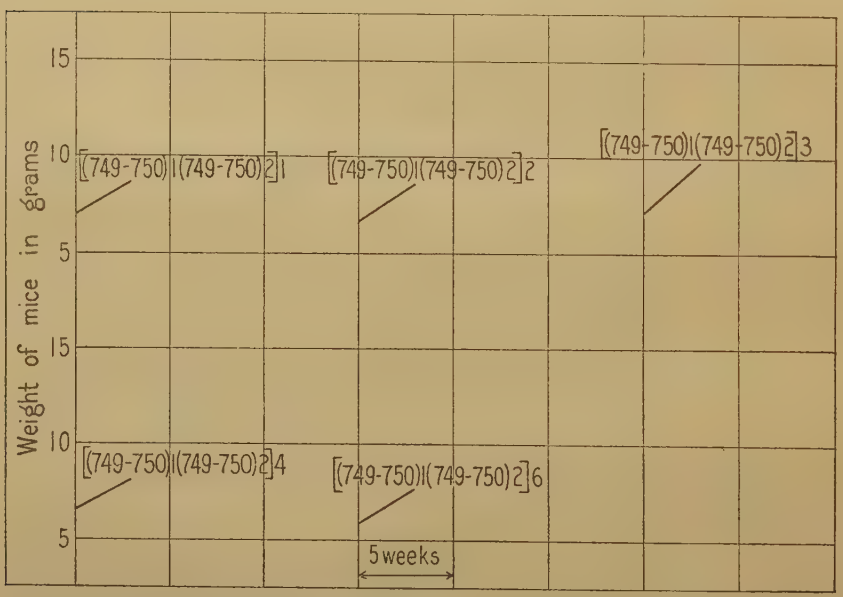


FIG. 24. These curves give the growth of the third generation on the diet that was fed to the animals whose growth is recorded in fig. 22. Growth was good in both cases.

crease the birth rate appreciably, and none of the young mice survived the period of lactation in either case.

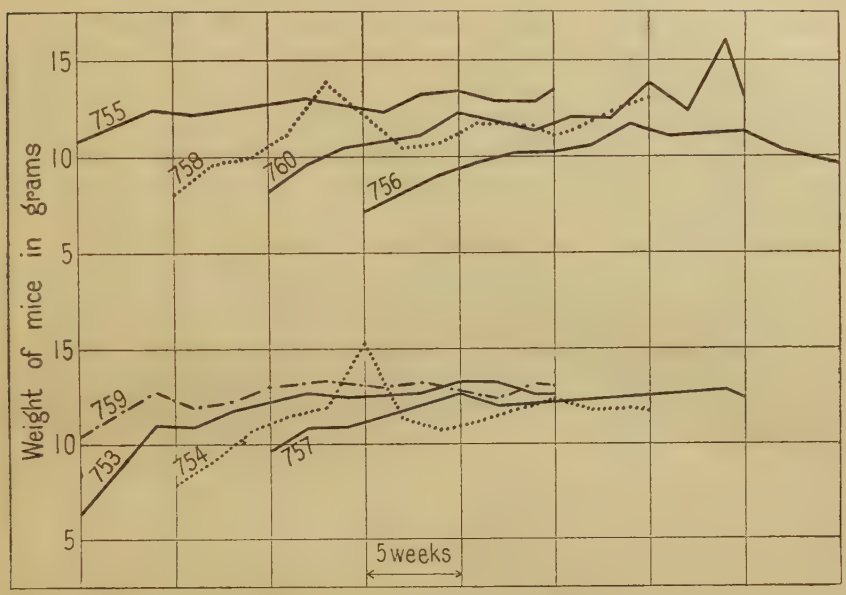


FIG. 25. These curves show the growth of the first generation of Chinese white mice on a diet which consisted of only white kaoliang, 50 per cent, and millet, 50 per cent. Growth was good; the addition of the millet improved the birth rate somewhat, but it was still below normal.

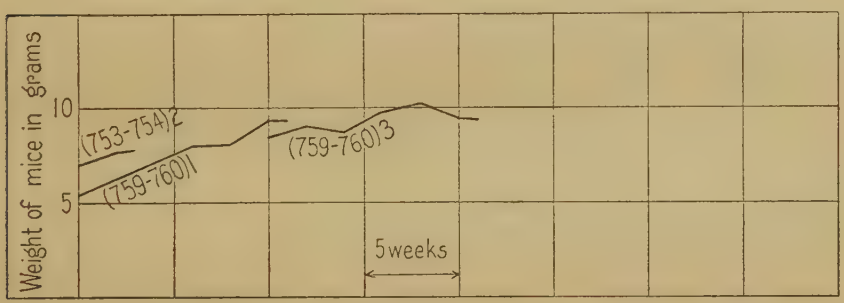


FIG. 26. These curves show the growth of the second generation on the diet that was fed to the animals whose growth is recorded in fig. 25. Three of the second generation lived through the period of lactation and were showing good growth at the termination of the experiment.

CONCLUSIONS

1. To increase the fertility of white mice and to assure good growth of the second generation, from among the foods tested, the best supplements for a mung-bean (*Phaseolus aureus* Roxburgh) diet are small quantities of fat-free peanut, of gelatine, or of casein. The best supplements for the white variety of edible sorghum (*Sorghum vulgare*) are small quantities of mung bean, of fat-free soy bean, or of fat-free peanut.

2. Not one of the foods tested as supplements to the red variety of *Sorghum vulgare* was able to raise the rate of reproduction of the first generation, nor the number of young of the second generation surviving the period of lactation, to normal. Casein, however, was a better supplementary food in a diet of red *Sorghum vulgare* than was mung bean, fat-free peanut, or fat-free soy bean.

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ILLUSTRATIONS

TEXT FIGURES

the fat removed by previous extraction with ether, 5 per cent; a mixture of salts, 3.7 per cent; starch, 2 per cent; butter, 5 per cent.

FIG. 8. These curves are for the second generation of mice on the diet that was fed to the animals whose growth is recorded in fig. 7. The rate of reproduction was slightly improved by the addition of 5 per cent of fat-free soy bean. Two of the second generation lived, and one of them reached normal weight.

9. These curves show the growth of the first generation of mice on the following diet: Mung bean, 92 per cent; sodium chloride and calcium carbonate, 3 per cent; egg white, 5 per cent. All of the first generation showed normal growth except one mouse, whose growth was slightly subnormal.

10. These curves show the growth of the second generation of mice on the diet that was fed to the animals whose growth is recorded in fig. 9. The addition of 5 per cent of egg white improved the rate of reproduction. Four of the young lived, and two of them attained normal growth.

11. These curves show the growth of the first generation on the following diet; Red kaoliang, 86 per cent; casein, 5 per cent; a mixture of salts, 4 per cent; and butter, 5 per cent. The addition of 5 per cent of casein improved the growth of the first generation on a red-kaoliang diet.

12. These curves represent the growth of the second generation of mice on the diet that was fed to the animals whose growth is recorded in fig. 11. While the addition of 5 per cent of casein improved the rate of reproduction, the six young of the second generation that lived seemed not to be gaining normally and the experiment was stopped.

13. These growth curves are for the first generation of mice on the following diet: Red kaoliang, 86 per cent; peanut, previously extracted with ether, 5 per cent; a mixture of salts, 4 per cent; butter, 5 per cent. The rate of reproduction was low, and none of the second generation survived.

14. These curves show the growth of the first generation of mice on the following diet: Red kaoliang, 86 per cent; soy bean, previously extracted with ether, 5 per cent; a mixture of salts, 4 per cent; and butter, 5 per cent. This diet produced only one litter of two mice, neither of which lived.

15. These curves give the growth of the first generation of mice on the following diet: Red kaoliang, 76 per cent; mung bean, 15 per cent; a mixture of salts, 4 per cent; butter, 5 per cent. Two litters of young were born, but only one mouse lived. Since the growth of this mouse was subnormal the experiment was discontinued.

16. These curves show the growth of the first generation of white mice on the following diet: White kaoliang, 86 per cent; casein, 5 per cent; a mixture of salts, 4 per cent; butter, 5 per cent. Growth was normal, and the reproduction was improved by the addition of 5 per cent of casein.

17. These curves show the growth of the second generation of mice on the diet that was fed to the animals whose growth is recorded in fig. 16.
18. These curves give the growth of the first generation of mice on the following diet: White kaoliang, 86 per cent; peanut, previously extracted with ether, 5 per cent; a mixture of salts, 4 per cent; butter, 5 per cent. The growth of the first generation was excellent, and reproduction was normal.
19. These curves show the growth of the second generation on the diet that was fed to the animals whose growth is recorded in fig. 18. All of the young lived through the period of lactation and were showing good growth at the termination of the experiment.
20. These curves give the growth of the first generation of mice on a diet of white kaoliang, 86 per cent; soy bean, previously extracted with ether, 5 per cent; a mixture of salts, 4 per cent; and butter, 5 per cent. Growth was excellent except in the case of one mouse. Reproduction was normal.
21. These curves represent the growth of the second generation on the diet that was fed to the animals whose growth is recorded in fig. 20. All of the young lived through the period of lactation and were showing good subsequent growth at the termination of the experiment. Before the termination of the experiment two litters of the third generation were born. The young of the third generation were showing good growth at the conclusion of the experiment.
22. These curves give the growth of the first generation of mice on a diet of white kaoliang, 76 per cent; mung bean, 15 per cent; a mixture of salts, 4 per cent; and butter, 5 per cent. The growth and the rate of reproduction were normal.
23. These curves give the growth of the second generation on the diet that was fed to the animals whose growth is recorded in fig. 22.
24. These curves give the growth of the third generation on the diet that was fed to the animals whose growth is recorded in fig. 22. Growth was good in both cases.
25. These curves show the growth of the first generation of Chinese white mice on a diet which consisted of only white kaoliang, 50 per cent; and millet, 50 per cent. Growth was good; the addition of the millet improved the birth rate somewhat, but it was still below normal.
26. These curves show the growth of the second generation on the diet that was fed to the animals whose growth is recorded in fig. 25. Three of the second generation lived through the period of lactation and were showing good growth at the termination of the experiment.

CHEMICAL ANALYSES OF THIRTY-SEVEN ORIENTAL FOODS

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Of the Laboratories of Food Chemistry, Peking Union Medical College Peking, China, and the Bureau of Science, Manila[1]

SEVEN PLATES

The foods discussed in this article were bought in the native markets of Peking, China. Most of them are unknown to the Occident, although many of them are found in the Philippine Islands and other places in the Orient.

As far as possible we have given the botanical classification, the Chinese characters, the Romanized local name in the Peking dialect and, for those foods found also in the Philippine Islands, the name in the Tagalog dialect.

These foods were analyzed for three main purposes: First, that the hospitals and schools in the Orient might be able to use these tables in working out special diets for the treatment of diseases materially affected by diet; second, that the expense of feeding patients might be appreciably lowered by the use of the native foods instead of the expensive imported canned goods; third, that the Western World might know eastern products and might consider the possibilities of introducing these new foods.

The methods used in the analyses were as follows: The proteins were determined as total nitrogen by the Kjeldahl method, and the percentage obtained multiplied by the factor 6.25.

The carbohydrates were determined by subtracting the sum of the percentages of water, fat, protein, ash, and crude fiber, as calculated on the wet basis, from 100.

The fats were determined as the anhydrous ether extract of the dried substance. The Soxhlet method of extraction was employed.

The ash was obtained by the usual ignition method.

The percentage of water was obtained by determining the loss of weight on drying to constant weight at a temperature of 100° C.

[1] The funds for the part of the work reported in this paper that was done in Peking were provided by the Rockefeller Foundation.

TABLE 1.—*Analyses of thirty-seven oriental foods.*

Analysis No. and Peking name of the food analyzed.	Water.	Fat.		Ash.		Protein.		Carbohydrate (calculated by difference).	Crude fiber.		Fuel value.	
		Dry basis.	Wet basis.	Dry basis.	Wet basis.	Dry basis.	Wet basis.	Wet basis.	Dry basis.	Wet basis.	Calories per pound.	Calories per 100 grams.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*		*P. ct.*	*P. ct.*		
1. Chieh ts'ai [a]	85.12	0.63	0.09	8.13	1.21	19.78	2.94	9.46	7.93	1.18	229	50
2. Chieh ts'ai ying	88.55	3.77	0.43	14.36	1.64	28.76	3.29	5.11	8.56	0.98	170	37
3. Chiao pai	91.05	3.35	0.30	6.87	0.61	13.34	1.19	5.84	11.29	1.01	140	31
4. Chi tzu ch'ing	87.61	0.13	0.02	4.44	0.55	78.85	9.77	2.05	-------	-------	215	47
5. Chi tzu huang	48.67	53.03	27.22	3.66	1.88	31.63	16.24	5.99	-------	-------	1,503	331
6. Chi tzu ch'ing	86.45	0.18	0.02	4.22	0.57	85.06	11.53	1.43	-------	-------	236	52
7. Chi tzu huang	51.23	52.89	25.79	3.22	1.57	31.56	15.39	6.02	-------	-------	1,431	315
8. Fan kua	94.49	1.37	0.08	10.63	0.59	11.71	0.65	3.61	10.53	0.58	81	18
9. Hao tzu kan	94.10	2.40	0.14	19.40	1.14	25.79	1.52	2.36	12.54	0.74	76	17
10. Hei lo po	76.96	0.46	0.11	3.78	0.87	10.49	2.24	18.13	6.55	1.51	378	83
11. Hsi hu lu	95.11	1.61	0.08	8.72	0.43	9.22	0.45	3.32	12.47	0.61	72	16
12. Hsi hu lu tzu	3.65	48.52	46.75	5.71	5.50	36.86	35.52	6.76	1.89	1.82	2,656	585
13. Hsiang ch'un	88.06	2.50	0.30	9.30	1.11	37.67	4.50	4.25	14.91	1.78	171	38
14. Huang chi ts'ai tzu	7.38	25.45	23.57	3.67	3.40	19.70	18.25	37.25	10.96	10.15	1,961	432
15. Huang hua ts'ai	85.49	2.77	0.40	5.35	0.78	11.42	1.66	10.44	8.48	1.23	236	52
16. Hung kuo	69.79	2.17	0.66	3.34	1.01	2.43	0.73	25.57	7.42	2.24	505	111
17. Hung tsao	21.32	0.46	0.36	1.60	1.26	2.90	2.28	72.56	2.82	2.22	1,375	303
18. Hu tzu	94.35	2.12	0.12	6.26	0.35	15.79	0.89	3.35	16.64	0.94	82	18
19. Kan lu	77.13	0.33	0.08	4.80	1.10	12.58	2.88	17.99	3.59	0.82	383	84
20. Lao mi	9.05	0.98	0.89	1.44	1.31	7.31	6.65	81.75	0.38	0.35	1,643	362
21. Mien chin	77.10	0.27	0.06	2.36	0.54	79.05	18.10	3.84	1.57	0.36	401	88

22. Nan kua	92.21	0.80	0.06	9.65	0.75	10.45	0.81	5.02	14.76	1.15	108	24
23. Pi ch'i (skin on)	71.19	0.44	0.13	4.10	1.18	5.65	1.63	24.63	4.30	1.24	483	106
24. Pi ch'i (skin off)	78.41	0.26	0.06	4.73	1.02	5.26	1.14	18.62	3.47	0.75	362	80
25. P'ieh lan	91.61	1.14	0.10	10.30	0.86	12.39	1.04	5.52	10.37	0.87	123	27
26. Shan yao	79.84	0.41	0.08	3.89	0.78	8.60	1.73	17.24	1.64	0.33	348	77
27. Ssu kua	93.16	2.20	0.15	10.28	0.70	19.73	1.35	3.98	9.65	0.66	103	23
28. T'ang hsi	22.49	-------	-------	1.31	1.02	1.02	0.79	75.70	-------	-------	1,391	306
29. Tung kua	96.53	0.81	0.03	11.31	0.39	11.25	0.39	2.15	14.70	0.51	47	10
30. Tz'u ku (skin on)	74.54	0.60	0.15	5.48	1.40	20.29	5.17	18.11	2.47	0.63	429	94
31. Tz'u ku (skin off)	73.74	0.62	0.16	4.98	1.31	19.04	5.00	19.24	2.09	0.55	447	98
32. Weng ts'ai	93.39	4.38	0.29	21.45	1.42	18.03	1.19	2.60	16.79	1.11	81	18
33. Wo kua	90.54	1.07	0.10	6.41	0.61	16.57	1.57	6.23	10.04	0.95	146	32
34. Wo kua tzu	3.52	49.22	47.49	5.01	4.83	37.28	35.97	6.29	1.97	1.90	2,686	592
35. Wo sun	96.85	1.32	0.04	23.39	0.74	22.97	0.72	1.33	10.16	0.32	39	9
36. Wo sun yeh	93.59	3.42	0.22	13.84	0.89	23.75	1.52	3.08	10.92	0.70	92	20
37. Yu ts'ai	93.18	3.67	0.25	21.32	1.45	27.04	1.84	2.45	12.17	0.83	88	19

[a] These names and the equivalent Chinese characters are shown on page 72.

Crude fiber was determined by the usual method.[2]

The calorie values were calculated by the Atwater and Bryant method as follows:

	Calories per gram.	Calories per pound.
Protein	4.0	1,815
Fat	8.9	4,040
Carbohydrates	4.0	1,818

Peking names of foods analylized and the Chinese characters for each name.

[The serial numbers are the same as those in Table 1.]

1 Chieh ts'ai 芥菜
2 Chieh ts'ai ying 芥菜纓
3 Chiao pai 茭白
4 Chi tzu ch'ing 鷄子青
5 Chi tzu huang 鷄子黃
6 Chi tzu ch'ing 鷄子青
7 Chi tzu huang 鷄子黃
8 Fan kua 番瓜(北京俗名)
9 Hao tzu kan 蒿子杆
10 Hei lo po 黑蘿蔔(北京俗名)
11 Hsi hu lu 西胡蘆
12 Hsi hu lu tzu 西胡蘆籽
13 Hsiang ch'un 香椿
14 Huang chi ts'ai tzu 黃芨菜
15 Huang hua ts'ai 黃花菜
16 Hung kuo 紅果
17 Hung tsao 紅棗
18 Hu tzu 鬍子
19 Kan lu 甘露
20 Lao mi 老米
21 Mien chin 麵筋
22 Nan kua 南瓜
23 Pi ch'i (skin on) 荸薺(帶皮)
24 Pi ch'i (skin off) 荸薺(去皮)
25 Pieh lan 鱉蘭
26 Shan yao 山藥
27 Ssu kua 絲瓜
28 T'ang hsi 糖稀
29 Tung kua 冬瓜
30 Tz'u ku (skin on) 慈菇(帶皮)
31 Tz'u ku (skin off) 慈菇(去皮)
32 Weng ts'ai 蕹菜
33 Wo kua 倭瓜
34 Wo kua tzu 倭瓜籽
35 Wo sun 萵笋
36 Wo sun yeh 萵笋葉
37 Yu ts'ai 油菜

SCIENTIFIC NAMES AND DESCRIPTION OF THE FOODS ANALYZED

1. Chieh ts'ai or ko ta is probably a variety of *Brassica campestris* Linnæus. It is a common food in Peking where the root and the top are both eaten. The lower part is known as chieh ts'ai and the upper part as chieh ts'ai ying. A congee made from this plant is supposed by the Chinese to "expel phlegm and prevent evil effluvia."[3] (See analysis 1; Plate 1, fig. 1.)

2. Chieh ts'ai ying, the leafy top of chieh ts'ai. (See analysis 2; Plate 1, fig. 2.)

3. Chiao pai is probably *Hydropyrum latifolium*. This plant is a tall grass about 5 or 6 feet high. It grows in marshy places.

[2] Leach, A. E., Food Inspection and Analysis. John Wiley & Sons, Inc. (1920) 277.

[3] Stuart, G. A., Chinese Materia Medica. American Presbyterian Mission Press (1911) 478.

The young shoot looks somewhat like a bamboo shoot. It is eaten both raw and cooked and has an agreeable sweetish taste. The central mass of this shoot, the part we analyzed, is also edible; it looks like a child's arm. The seeds, which are nearly an inch long, have a grayish cuticle and a white starchy interior. In times of famine they are often used as a substitute for rice. (See analysis No. 3; Plate 1, figs. 3 and 4.)

4. Chi tzu ch'ing is the local name of the white of ordinary hens' eggs. Hens' eggs bought in the Peking markets are small, weighing usually only about 35 to 37 grams as compared with 58 to 60 grams, the weight of the average hen's egg in the United States. The mean percentage composition of the European hen's egg, according to König, is water, 73.67 per cent; proteins, 12.55 per cent; fat, 12.11 per cent; nitrogen-free substance, 0.55 per cent; and salts, 1.12 per cent. In the dry substance, nitrogen 7.66 per cent and fat 45.99 per cent.

Wood and Merrill give the following analyses:[4]

	H_2O.	Protein.		Fat.	Ash.
		N × 6.25.	By difference.		
White of hen's egg	86.2	12.3	13.0	0.2	0.6
Yolk of hen's egg	49.5	15.7	16.1	33.3	1.1

5. Chi tzu huang, the yolk of hen's egg. Analyses 4 and 5 are the white and the yolk, respectively, of the same Peking hen's egg.

6. White of hen's egg.

7. Yolk of hen's egg. Analyses 6 and 7 are the analyses of the white and the yolk of another Chinese egg.

8. Fan kua, perhaps a variety of *Cucurbita maxima* Duchesne. The color of the upper part of the exterior is green and white. The color of the lower part is green and yellow. The color of the meat is cream. This melonlike vegetable is large, and measures 24 inches around the middle. (See analysis 8; Plate 2, figs. 1 to 4.)

9. Hao tzu kan, *Chrysanthemum coronarium* Linnæus, is a highly esteemed green leaf vegetable. It is also found in the Manila markets, and is known in the Philippine Islands by the name tanñgú. (See analysis 9.)

[4] Leach, A. E., Food Inspection and Analysis. John Wiley & Sons, Inc. (1920) 267–269.

10. Hei lo po or tzu ta ken, probably *Arctium lappa,* seems to be a variety of edible burdock. It is almost black outside and the meat is purplish white. (See analysis 10; Plate 1, figs. 5 and 6.)

11. Hsi hu lu, perhaps a variety of *Cucurbita pepo* Linnæus, appears to be a kind of vegetable marrow. The exterior shows a smooth skin of dark green. The color of the meat is yellow. It is rather large, the circumference lengthwise measures 24 inches and around the middle 17 inches. (See analysis 11; Plate 3, figs. 1 to 4.)

12. Hsi hu lu tzu, the seeds of hsi hu lu. In China most feasts start with watermelon seeds, or some other seed of a like nature. The seeds of the hsi hu lu are also dried and used as a food. (See analysis 12.)

13. Hsiang ch'un, probably *Cedrela sinensis,* is the leaf of a tree found in the vicinity of Peking. The wood of this tree resembles mahogany and is used in cabinet work. In the spring the boiled tender leaves are used as a food. They are much liked on account of their fragrant odor. They are often used for medicinal purposes in China and are regarded as carminative and corrective. A feeding experiment on white rats, which will be reported in another place, shows that when the food is concentrated by drying and when the dried food is added to a complete diet a strong toxic principle present in hsiang ch'un causes violent convulsions and death. (See analysis 13.)

14. Huang chi ts'ai tzu or huang hsu ts'ai tzu, translated literally, means "yellow-grain vegetable seeds," and is unidentified scientifically. It is a sort of small black seed used as a food. These seeds are said to come from a plant that grows abundantly on the dry alkaline soil along the coastal plain of Chihli Province in China, where almost nothing else grows. The plant is from 6 inches to 2 feet in height. It has green leaves and yellow blossoms which the inhabitants are forced to use as a means for subsistence, both for themselves and for their animals. The small black seeds are more valuable than the leaves and blossoms, and when mixed with flour, are used as a higher-class food. We analyzed the seed only. (See analysis 14; Plate 2, fig. 5.)

15. Huang hua ts'ai, *Hemerocallis fulva,* are dried yellow flowers that are used as a food. The Filipino market name is bulaklak nang saging, because it is erroneously supposed to have some connection with the banana. (See analysis 15; Plate 2, fig. 6.)

16. Hung kuo, perhaps *Mespilus cuneata* Siebold and Zuccarini, is a small round red acrid fruit. It is often dipped into a sugar sirup and mounted on sticks, and is sold commonly on the streets of Peking as a confection. (See analysis 16.)

17. Hung tsao, probably *Zizyphus vulgaris*, are the reddish black seeds of a plant that grows to the height of several feet. These seeds when steamed are used as a food. They are also said to have some medicinal value, being reputed to relieve thirst and fever. (See analysis 17.)

18. Hu tzu, *Lagenaria vulgaris* Seringe, is a slender variety of gourd-shaped vegetable belonging to the same family as the Philippine upo. Its color is green. The meat is white. Its length is about 30 inches and its diameter about 2 inches. (See analysis 18; Plate 3, figs. 5 and 6.)

19. Kan lu, not identified; perhaps *Stachys sieboldi* Miguel. A vegetable found in the Peking market, analyzed shortly before our departure. We have found no similar vegetable in the Manila markets, and on account of insufficient information brought with us from China have been unable to identify it more completely. (See analysis 19.)

20. Lao mi, or *Oryza sativa* Linnæus, is a kind of fermented rice. During the Manchu régime large quantities of rice were brought to Peking for the use of the Manchu population, all of whom were under Government pension. The rice was stored away in large warehouses. It is said that after a certain period of storage, the rice became very hot. It was probably undergoing some sort of fermentation. After five years it became purple. At this stage it became known as lao mi, or old rice. It is considered a delicacy, having a peculiar flavor quite different from that of ordinary rice. (See analysis 20; Plate 5, fig. 4.)

21. Mien chin, a preparation made from wheat flour by several methods. One of the commonest procedures is as follows: Wheat flour is mixed with a dilute salt solution to form a thick paste. The paste is set aside in a cold place for about twenty minutes. After it is well coagulated, it is washed through a bamboo sieve with cold water. The sticky part that remains on the sieve is called mien chin. From its high protein content, this glutinous food is valuable as a meat substitute in the Chinese diet. (See analysis 21.)

22. Nan kua, probably a variety of *Cucurbita maxima* Duchesne, or of *C. pepo* Linnæus, is a large round white vegetable. The meat also is white. (See analysis 22; Plate 4, figs. 3 to 6.)

23. Pi ch'i, *Eleocharis tuberosa,* is a plant that grows in shallow water. The tubers are black externally. They are sometimes called ground chestnut or water chestnut because they somewhat resemble the chestnut in appearance although not at all in flavor. The plant has been imported from China to the Philippine Islands, where it is known as apulid tsina. The tubers are eaten both raw and cooked. Analyses were made of the tubers with and without the outer skin. (For analysis of pi ch'i with the skin on, see analysis 23; Plate 5, figs. 1 to 3.)

24. Pi ch'i, analysis was made with the outer skin removed. (See analysis 24.)

25. P'ieh lan, apparently a variety of *Brassica campestris* Linnaeus, seems to be a sort of kohl-rabi. The exterior is pale green and is smooth except for a few circular ridges. The color of the meat is white. The edible portion grows above ground. (See analysis 25; Plate 6, figs. 1 to 4.)

26. Shan yao, *Dioscorea batatas* Decaisne, is a plant somewhat like the potato. It resembles the potato in color but has short stiff hairs, about one-eighth of an inch long, on its surface. There are enzymes present which darken the cut portion in the presence of air. (See analysis 26; Plate 3, figs. 7 and 8.)

27. Ssu kua, *Luffa cylindrica* (Linnæus) M. Roemer, is perhaps a slender form of the Filipino kastila. It is of a mottled green color and has lengthwise ridges. (See analysis 27; Plate 5, figs. 5 to 8.)

28. T'ang hsi is a sweetish sirup widely used in North China. As nearly as we could ascertain, the food is prepared as follows: Barley is sprouted in a willow vessel until it is about a half inch long and then it is ground fine. Millet is steamed, mixed with an equal portion of the sprouted barley, and the mixture is moistened. This mixture is allowed to ferment in a warm place, and after fermentation is poured into hot water to digest at 70 to 80° C. for about six or eight hours. The juice is filtered through a mat and transferred to a large boiler where it is concentrated while being stirred frequently, in order that it may be brought to the proper consistency without charring. This thick sirup is much appreciated by the Chinese. (See analysis 28.)

29. Tung kua, *Benincasa hispida* Cogniaux, is the kondol of the Philippine Islands. In the Philippine Islands it is also called tan kua or seikey. It is used as a vegetable or, when preserved with sugar, as a sweetmeat. The seeds are believed by the Chinese to have medicinal value, and a famous prescription calls

for the use of these seeds incinerated and taken internally for the treatment of gonorrhœa. The pulp of this gourd is considered by the Chinese to be a diuretic, and is used in the treatment of gravel. The Chinese also add it to baths for the treatment of prickly heat.[5] (See analysis 29; Plate 7, figs. 5 to 7.)

30. Tz'u ku, *Sagittaria sagittifolia* Linnæus, is a tuber that grows in shallow water. In the fall and early spring the tubers are dug up and cooked for food. This plant is not now grown commonly in the Philippine Islands, but has succeeded very well in the garden of a Filipino botanist in Manila. A sort of arrowroot is sometimes made from the tender stalk. We analyzed the tubers only, both with and without the outside skin. (For analysis of tz'u ku with skin, see analysis 30; Plate 7, figs. 1 to 3.)

31. Tz'u ku was also analyzed without the skin. (See analysis 31.)

32. Weng ts' ai, *Ipomoea reptans* Poiret, is a green leaf vegetable probably identical with the Filipino kangkong or tankong. The green resembles spinach in flavor. (See analysis 32.)

33. Wo kua, probably a variety of *Cucurbita pepo* Linnæus, is one of the numerous squashlike vegetables found in Peking. The color of the exterior is medium green with yellow spots. The meat is orange colored. The vegetable and the seeds were both analyzed. In Manila a similar vegetable is called kalabasang pula. (For analysis of the vegetable see analysis 33; Plate 6, figs. 5 to 8.)

34. Wo kua yeh, the seeds of wo kua, were also analyzed. Melon and squash seeds are a popular food in the Chinese diet. (For analysis of the wo kua seeds see analysis 34.)

35. Wo sun, perhaps a variety of *Lactuca sativa* Linnæus, is a lettuce-root sort of vegetable, but it also has some characteristics of a *Brassica*. The color of the outside of the stalk is pale green. It is about 10 inches in length. The edible portion grows above the ground. The root, wo sun, and the leaves, wo sun yeh, were both analyzed, since both are used as foods. Analysis 35 is the analysis of wo sun. (See Plate 4, figs. 1 and 2.)

36. Wo sun yeh, the leafy part of wo sun, analysis 36.

37. Yu ts'ai, *Brassica rapa* Linnæus, is one of the numerous green vegetables found in the markets of Peking. From the seeds of this plant is expressed the oil known as rape-seed oil,

[5] Stuart, G. A., Chinese Materia Medica. American Presbyterian Mission Press (1911) 67.

ts'ai yu. Until the introduction of kerosene, rape oil was used in China as an illuminant, and it is still used for culinary purposes. The green part is eaten in the spring, and this is the part we analyzed. The Chinese believe that the juice expressed from the stalk and the leaves of this plant is of medicinal importance. They give it in dysentery, and also apply this juice to sores, caked breast, cancer, etc. (See analysis 37; Plate 7, fig. 4.)

ILLUSTRATIONS

Plate 1

Fig. 1. Chieh ts'ai ying, exterior.
2. Chieh ts'ai ying, cut to show interior.
3. Chaio pai, exterior.
4. Chaio pai, edible central portion.
5. Hei lo po, exterior.
6. Hei lo po, cut to show interior.

Plate 2

Figs. 1 to 3. Fan kua, exterior, three views.
Fig. 4. Fan kua, cut to show interior.
5. Huang chi ts'ai tzu.
6. Huang hua ts'ai, two views.

Plate 3

Figs. 1 to 3. Hsi hu lu, exterior, three views.
Fig. 4. Hsi hu lu, cut to show interior.
5. Hu tzu, exterior.
6. Hu tzu, cut to show interior.
7. Shan yao, exterior.
8. Shan yao, cut to show interior.

Plate 4

Fig. 1. Wo sun, exterior.
2. Wo sun, cut to show interior.
Figs. 3 to 5. Nan kua, exterior, three views.
Fig. 6. Nan kua, cut to show interior.

Plate 5

Figs. 1 to 3. Pi ch'i, exterior, three views.
Fig. 4. Lao mi.
Figs. 5 and 6. Ssu kua, exterior, two views.
7 and 8. Ssu kua, cut to show interior, two views.

Plate 6

Figs. 1 to 3. P'ieh lan, exterior, three views.
Fig. 4. P'ieh lan, cut to show interior.
Figs. 5 to 7. Wo kua, exterior, three views.
Fig. 8. Wo kua, cut to show interior.

Plate 7

Figs. 1 and 2. Tz'u ku, exterior, two views.
Fig. 3. Tz'u ku, cut to show interior.
4. Yu ts'ai, exterior.
Figs. 5 and 6. Tung kua, exterior, two views.
Fig. 7. Tung kua, cut to show interior.

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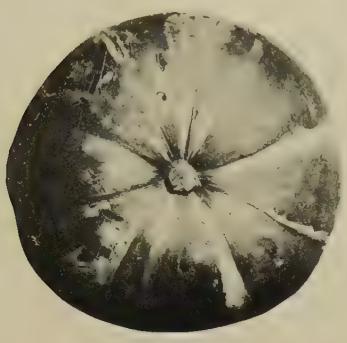
PLATE 1.



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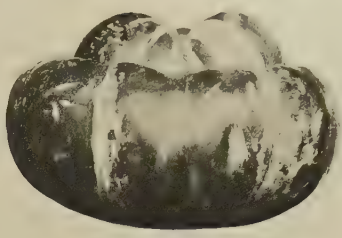

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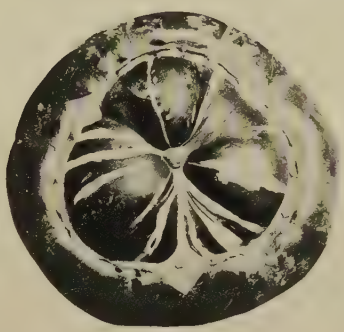

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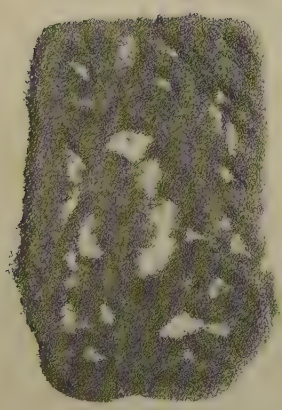

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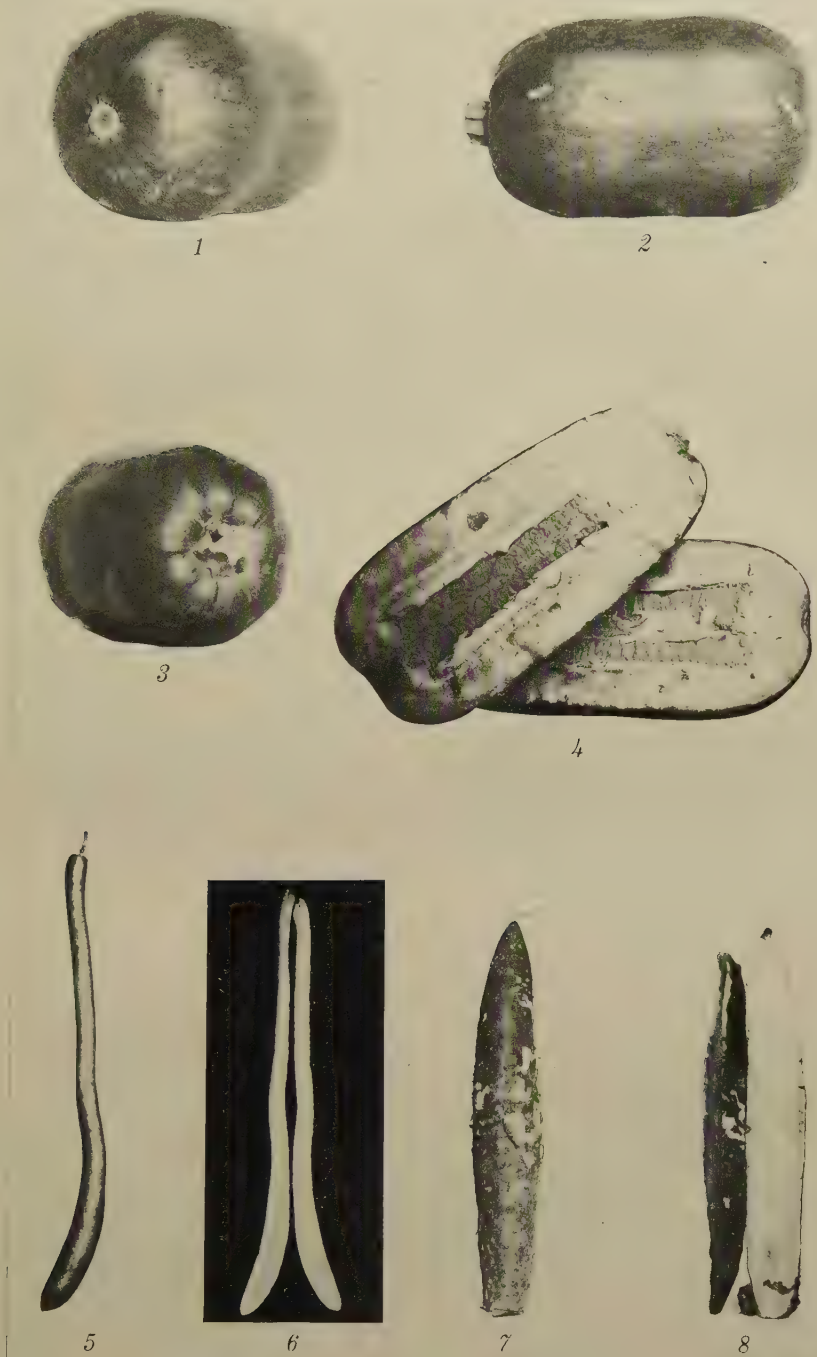

PLATE 3.

PLATE 4.

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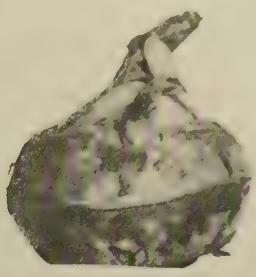

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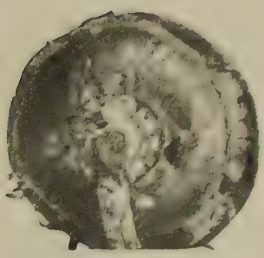

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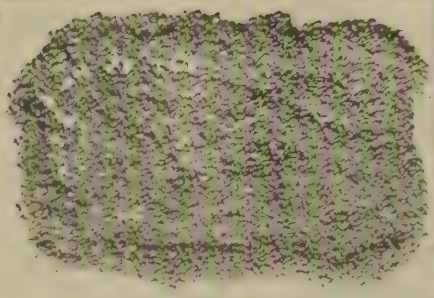

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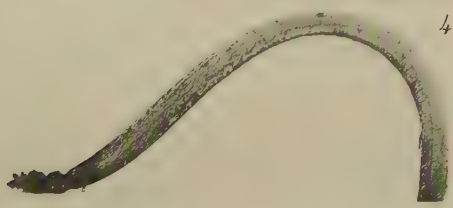

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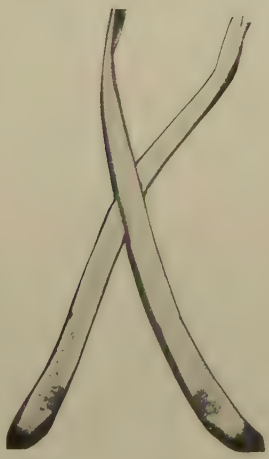

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PLATE 5.

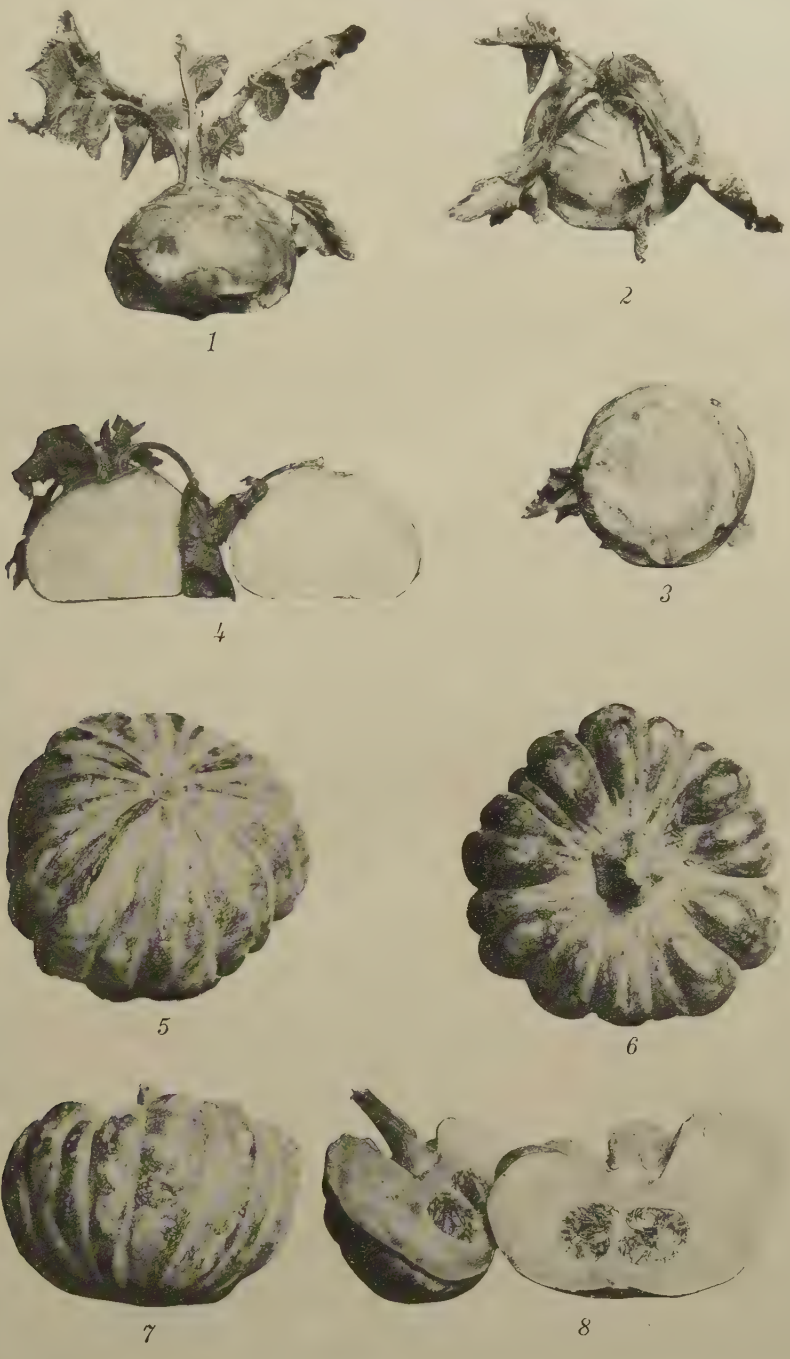

PLATE 6.

PLATE 7.

CALCIUM, IRON, AND MAGNESIUM CONTENT OF SIXTEEN CHINESE FOODS

By HARTLEY EMBREY SHERMAN and TSAN CH'ING WANG

Of the Laboratories of Food Chemistry, Peking Union Medical College Peking, China, and the Bureau of Science, Manila [1]

In view of the constantly increasing importance that is being attached by food experts to the presence of small quantities of certain minerals found in foods, sixteen common food substances were purchased in the Peking markets and analyzed for mineral content.

TABLE 1.—*Percentage of iron and aluminum, calcium, and magnesium in the ash of sixteen Chinese foods.*

Analysis No.	Name of food.	Aluminum (Al) and iron (Fe) calculated as aluminum oxide (Al_2O_3) and iron oxide (Fe_2O_3).	Calcium (Ca) calculated as calcium oxide (CaO).	Magnesium (Mg) calculated as magnesium oxide (MgO).
1	Huang tou	0.49	7.45	7.34
2	Huang tou ya [a]	0.43	10.96	8.63
3	do [b]	0.33	7.53	8.25
4	Green bean	0.62	9.31	7.41
5	Green-bean sprout (in hydrant water)	0.41	11.14	8.50
6	Green-bean sprout (in distilled water)	0.44	8.25	8.14
7	Mung bean	0.59	5.16	8.33
8	Mung-bean sprout (in hydrant water)	0.32	8.89	9.51
9	Mung-bean sprout (in distilled water)	0.45	3.39	7.32
10	Hsiang ch'un	2.59	15.72	5.36
11	Chiao pai	0.16	1.05	2.35
12	Tz'u ku	0.12	1.74	3.48
13	Yu ts'ai	0.68	13.56	5.59
14	Hao tzu kan	0.76	9.92	4.03
15	Hung kaoliang	1.64	2.42	13.17
16	Pai kaoliang	2.77	9.97	7.16
17	P'ieh lan	0.13	9.55	3.71
18	Hsi hu lu	0.14	4.50	4.33
19	Wo kua	0.09	5.27	3.38

[a] Yellow soy bean, sprouted in Peking hydrant water.

[b] Some of the same lot of yellow soy beans, sprouted in distilled water.

The methods used for these analyses are the usual ones as given by Leach.[1]

The scientific names and the descriptions of all the foods mentioned in this paper, with only two exceptions, are found in the preceding paper on the chemical analyses of thirty-seven oriental foods. The two foods not described in the above paper, pai kaoliang and kung kaoliang, have been described elsewhere.[2]

All of the sprouts in distilled water have a lower calcium content than the same kind of sprout grown in the notably hard water of Peking. This part of the analytical work was done in order to gain some idea of the degree of variation in mineral content one might expect when the same food is grown under different soil conditions. Since the soil around Peking is rich in lime, probably all the foods analyzed show a somewhat higher calcium content than the same food substances grown elsewhere in a different type of soil.

[1] Leach, A. E., Food Inspection and Analysis. John Wiley & Sons, Inc. (1920) 311.

[2] Embrey, Hartley, and T. C. Wang, China Med. Journ. 35 (1921) 247.

A STUDY ON THE CRANIAL CAPACITY OF FILIPINOS

By Juan C. Nañagas

Of the College of Medicine, University of the Philippines, Manila

THREE PLATES AND FIVE TEXT FIGURES

INTRODUCTORY REMARKS

There exists a wide general desire to understand more accurately the various racial characteristics of the Malays; to know in a more-detailed degree the anthropometric condition and structural development of the different groups of the brown race and to understand more particularly the characteristics that are inherent in one of their more-advanced groups, represented, we believe, by the Filipinos. The last objective is specially aimed at in our local institution for the beneficent purpose of devising and adopting measures that will help further to improve the physical development of the race. In recent years there has been some interest in the study of the ethnographic and anthropogenic history of the Filipinos and of such problems as revolve upon the ever-perplexing question of supposed correlation of racial potentialities, mental or physical, with the state of body development, the size of the head, or the volume of the brain case.

The writer has been asked many times about the weight of the brain, or the size of the head, or the volume of the cranial contents of Filipinos. These inquiries come from foreigners and Filipinos alike, and equally from scientists, professionals, and laymen. We hope that the present study will satisfy, to some extent, the seemingly long-felt want of knowing at least one of those characteristics.

We are rather fortunate that within six years the Department of Anatomy of the University of the Philippines has been able to collect and carefully prepare around six hundred crania from cases that possess definite histories and clinical records. Therefore, the present work is based on a fair number of known cases of Filipino skulls. This paper is intended to serve as an opening report, to be followed by other work on craniometry, which will be based on the same collection of skulls.

It is unfortunate that we cannot give a historical sketch of the study of Filipino crania. We have carefully searched for literature available locally on the subject, dealing with Filipinos or the Malay race, and we found very few reports on the cranial capacity of the race. Past work comprised isolated reports, each covering only one or few cases and dealing mainly with general anthropologic or ethnographic points, rather than with the dimentional characteristics. The craniometric points considered, besides being general in nature, were not based on carefully studied methods and technic. Such lack of uniformity in statistical procedure certainly does not permit a fair comparison of the results obtained in the past with those derived from the present work. In view of the above objections and difficulties, no review of literature is included in this paper.

MATERIAL FOR THE PRESENT STUDY

The cranial material was collected from cases sent to the morgue of the City of Manila that were not claimed by the families. They were received from the various districts of the city, not only from the various hospitals but also from all public-welfare institutions of the Government. Soon after the proper official permit is obtained, the head is removed from the body and all the soft tissues are dissected out. The brain substance and the meninges are then removed piecemeal through the foramen magnum. The sawing-off of the skull cap from the rest of the cranium for the purpose of removing the cranial contents was never resorted to in any of our series, in order to preserve the integrity of the skull. For this reason the brain tissues are removed as thoroughly as possible through the foramen magnum. The striped skull is then boiled in water to soften and eventually take away all the remaining soft tissues. The addition of Gold Dust powder was found to hasten the softening of adherent tissues. The boiling is continued for about twelve hours, until the bone is entirely free from attached ligaments and periosteum. The skull is thoroughly washed in tap water and is then allowed to remain immersed in running water for seven days. It is again carefully washed, and the cranial cavity finally inspected and cleaned. The specimen is then dried in the sun, and exposed to direct sunlight for about three more days, or until the skull is properly dried and fairly bleached.

The above method of preparation is rather tedious and consumes much attention and labor, but it was found to give in our

hands the best result as compared with various other methods that we have tried. A skull so prepared is not surpassed in strength, cleanliness, and whiteness by specimens obtained under other procedures that do not employ chemicals for cleaning and whitening the bone.

The number of skulls prepared in this manner exceeds the actual number used in the present study. This is due to the fact that we have some crania of the collection assigned or distributed to several institutions in the Islands for instructional purposes, and these we failed to include in this series that we are reporting. This work includes altogether four hundred and thirty-six cases. Each of these skulls was thoroughly and carefully measured by two members of our departmental staff, Doctors Cuajunco and Encarnacion, whose persistent interest and painstaking attention in making careful and uniform measurements, have made possible the present paper.

The institutions in Manila that have contributed to the present collection are the following:

	Skulls.
Bilibid Prison	389
City hospitals	32
Other places in the City of Manila	10
City asylums	5

It will be noticed that a great majority of the cases came from the Government penitentiary; this is because most of the pauper cases, unclaimed by families, came from that institution. These prisoners were gathered from different parts of the Islands for long terms of confinement in the central penitentiary. This incidence might be interpreted to carry considerable significance by criminologists; however, the facts and findings from this study will be reported without discussing such a complex and complicated question. This undesirable incidence of this series cannot be helped, nevertheless it cannot be denied that all the cases belong to the same race. Whatever unfavorable and critical interpretations may be given to our findings, because of this peculiar feature, should be welcomed; they may be of help in elucidating certain questions of criminological interest. Because of the relatively small size of the present collection, the writer does not consider and will not claim that his results are typical or settled standards for Filipinos, and precisely because of this fact the title of this article is "a study on the cranial capacity of Filipinos."

The average age of this series of crania is 41 years. The age distribution of the cases is shown in Table 1 and in fig. 1.

TABLE 1.—*Age-frequency table of cases.*

Age limits.	Frequency.	Percentage.	Age limits.	Frequency.	Percentage.
Years.			*Years.*		
15–20	21	4.82	61– 65	28	6.42
21–25	45	10.32	66– 70	7	1.60
26–30	60	13.76	71– 75	6	1.38
31–35	70	16.06	76– 80	5	1.15
36–40	57	13.07	81– 85	2	0.46
41–45	41	9.40	86– 90	2	0.46
46–50	43	9.86	91– 95	5	1.15
51–55	16	3.67	96–100	1	0.23
56–60	27	6.19			
			Total	436	100

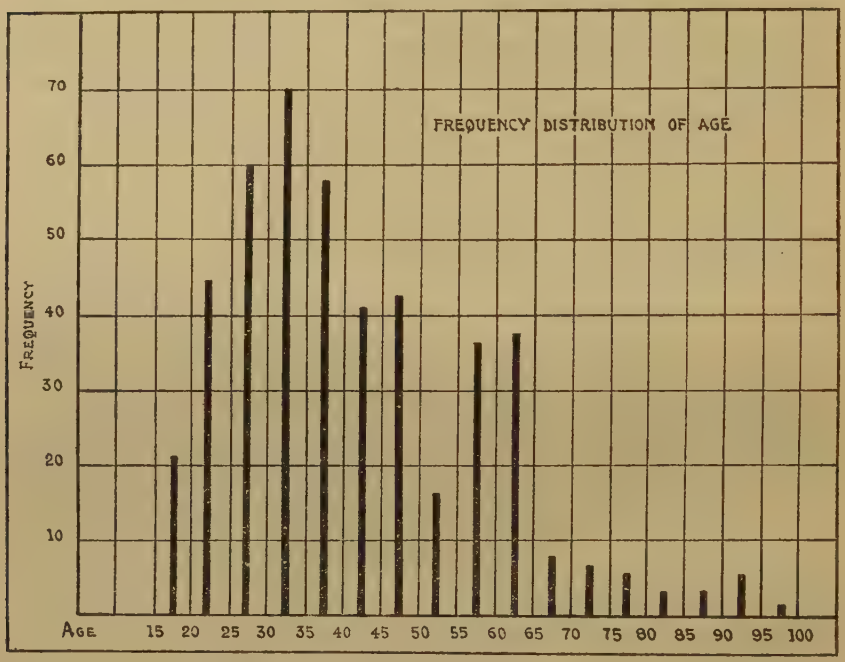

FIG. 1. Curve of age distribution.

From the age-frequency table and the corresponding graph it is seen that about 30 per cent of the cases are between the ages of 26 and 35 years, and that a little over 53 per cent of the series are between the ages of 21 and 40 years. It is fair to conclude, therefore, that this series belongs to the adult, or mature, group of the population.

The geographic distribution of all the cases we have studied in this work is given in Table 2 and in the circular diagram, fig. 2.

TABLE 2.—*Geographic distribution of cases.*

Region of the Philippines.	Frequency.	Percentage.
City of Manila	29	6.65
Ilocano provinces	53	12.16
Pampanga and Pangasinan Provinces	38	8.71
Tagalog provinces	92	21.10
Bicol provinces	27	6.19
Eastern Visayan provinces	102	23.39
Western Visayan provinces	61	14.00
Mindanao and Palawan Province	21	4.82
Undetermined cases	13	2.98
Total	436	100

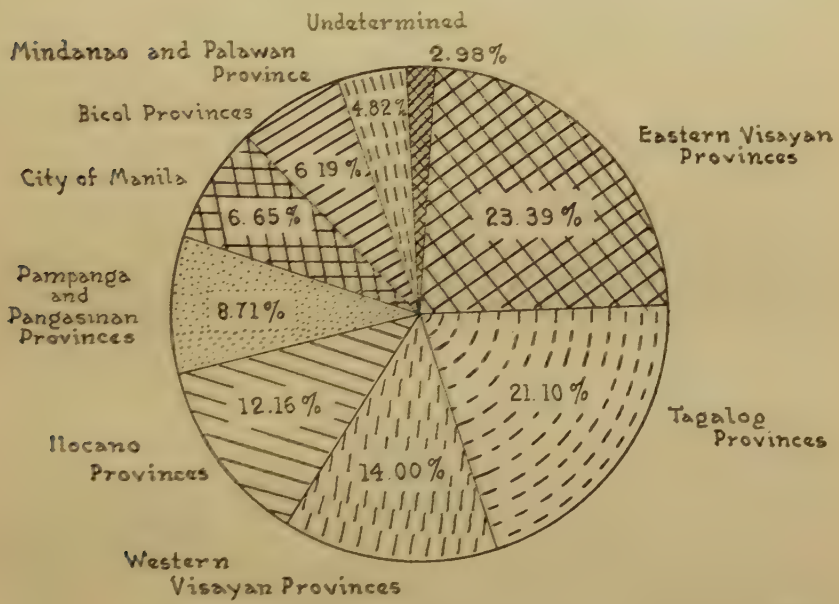

FIG. 2. A circle diagram illustrating the geographic distribution of cases under study.

The geographic groups that are most represented in this series, as distinctly demonstrated in fig. 2, are the eastern Visayan and the Tagalog provinces, comprising more than 20 per cent of the cases for each group. The next two regions showing a representation of over 10 per cent are the western Visayan and the Ilocano provinces. It appears that the representation in this series of the various provinces is in direct relation or proportion

to the degree of the actual density of population of the various regions of the Islands, as borne out by the Philippine Census of 1918. We are glad to note that such a correlation occurs in this report, as it enhances the value of this study, because it shows that the provincial groups of our people are well represented in this series of crania.

MEASURING EQUIPMENT AND TECHNIC

The direct determination of cranial capacity, or the direct measurement of cubage of the cranial vault, has been employed for over a century and a half. It was Soemmering who first attempted to measure the capacity of the cranial vault with water in the year 1785. Since then many varieties of technic have been devised—some simple, others more-complicated procedures, either in the materials employed or the mechanical devices used; or in the matter of personal equation and individual errors possible during measurements, and even in the mathematical calculations resorted to—to make the results fairly uniform and comparable. Because of certain obvious drawbacks in employing water to measure the cranial capacity of dried skulls, other materials have been introduced by various investigators. Sand was first used in 1831 by Hamilton. Tiedmann in 1837 introduced the use of millet which soon was substituted by pepper seeds in 1839, and then by shot in 1849 as first employed by Morton. Broca later introduced the standardization of the use of shot, and with his critical and careful investigations he contributed one of the best standard works on the study of cranial capacity. Broca's studies were begun in 1861 and were responsible for creating a much more enthusiastic attitude towards the investigation of problems on craniometry. Other materials have since been employed, such as, vegetable grains, glass beads, aluminum shot, rubber bags, pig's bladders, plaster casts, and mercury—all of which have been used as accessories in determining the cranial capacity by the so-called direct method.

In the beginning of the nineteenth century students commenced to follow similar investigations upon what was referred to as "green skull." The skull used was fresh from the cadaver, with the dura mater left intact, instead of the "dry skulls" employed by earlier observers. This was originated by Zanka in 1897 and followed by Pfister, Reichert, and Vitali in later years. The latest work regarding this method was that of Todd, in 1923, who carefully employed the water method on green skulls of cadavers in measuring cranial capacity.

The description of the technic of the various types of determination of cranial capacity are well given in a historical sketch by Todd and in synoptic form in the publications of Martin and of Hrdlička. The details of methods and the mathematical procedures in working out the problem are given in the two former publications, and the details of the necessary measurements and the mistakes and the errors that may be committed or encountered in the process and the devices recommended to minimize them are explained in the publications of the last author.

It is almost proverbial in works on craniometry that each author, when submitting the result of his work, considers his method and technic as the optimum, and even tries to present his results in the best light possible to prove his contention. Under these conditions, it is difficult to make a choice of the best method to follow. The great variety of technic followed by different investigators would not seem to allow an ideal comparison of results, without a certain degree of skepticism. It is, of course, believed that each kind of cranial material will need a certain type of procedure; thus, the green-skull series requires one method, while the dried-skull group requires another.

In our study and choice of technic for the determination of cranial capacity in this series, we deemed it advisable to devise certain modifications of the instruments recommended by Hrdlička as used by Flower for volumetric measurements. Careful attention has been directed towards eliminating, as much as possible, sources of error that were attributable to personal influences in order to reduce, as Hrdlička particularly emphasized, the capacity determination to a mechanical procedure, so as to make it an easy process and to minimize the effect of personal equation on the whole process and on the results.

The measuring equipment that we have used is shown on Plate 1 and is as follows:

One zinc vessel with attached funnel (measuring receptacle).
One wooden stand with a folding platform.
Two graduated cylinders of 2,000 cubic centimeters capacity.
One wooden hammer with rubber pads.
Two wooden ring cushions.
One large enamel tray.
Three glass jars of about 2,500 cubic centimeters capacity each.
Fine sand, 4,000 cubic centimeters.
Mustard seed, 4,000 cubic centimeters.
Shot, size No. 8 of 2.2 millimeters diameter, 4,000 cubic centimeters.
Bronze sieve manufactured by The W. S. Tyler Co., Cleveland, Ohio. Sieve is double crimped with 60 meshes to the inch, and with the opening 0.0087 of an inch.

Adhesive-plaster ribbon 1 inch wide.
One hard-rubber funnel.
One large spoon.
One tin spatula.

The measuring receptacle and attachments that we have devised and constructed consist of a zinc vessel, a four-legged wooden stand, and a folding platform at the middle. The vessel is similar in construction to Flower's and is provided with an attached funnel at the lower end. It is 24 centimeters high, with a diameter of 20 centimeters. The funnel is about 45° dip and contains a circular outlet of 20 millimeters. This outlet is guarded by a traplike arrangement consisting of a movable plate of zinc, so placed that it can be pushed in or pulled out for a distance of 3.5 centimeters in opening and closing, re-

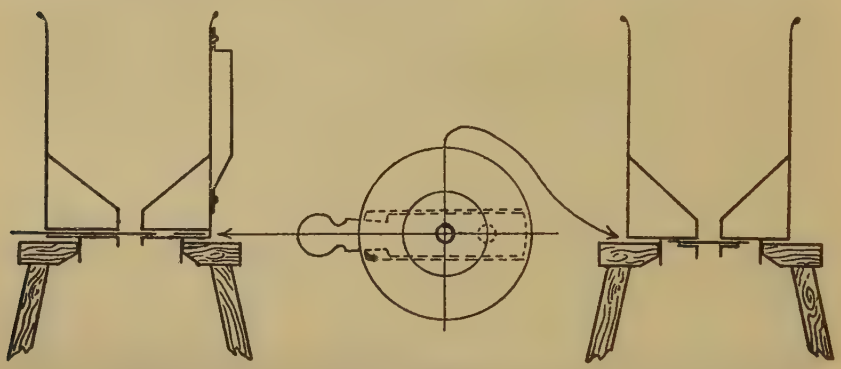

FIG. 3.. Diagramatic sections of the tin receptacle and funnel used in cranial-capacity measurement.

spectively, the funnel outlet with the least possible jar. This sliding plate is closely and snugly fitted at the bottom of the vessel in such a way that, although it allows a sliding movement in one direction, it does not permit the measuring materials to enter the spaces around the sliding plate and interfere with its function. This zinc plate is provided with a circular opening at the middle portion, so placed that on sliding backward it exactly coincides with the outlet of the funnel to release the material contained in the vessel. Cross sections of this part are represented in fig. 3 outlining its rather simple mechanism. The wooden stand that we have devised forms the support of the zinc vessel when measuring. It is high enough to permit placing under it either the skull or the graduated cylinder, below the zinc vessel to receive the measuring material coming from the receptacle. This stand, together with its attached platform,

is found to be of great service in holding the vessel steadily without any appreciable vibration when the cranium or the cylinder is being filled by measuring material. The device minimizes errors in measurement that are attributable to unnecessary motions or vibration from the unsteady support of either the skull or the funnel. The wooden platform is placed at the middle horizontal level of the stand and is here supported with hinges behind and releasable hooks in front. This can thus be folded downward at will to give place for the graduated cylinder. This platform is used for the support of the cranium while it is in position to receive the measuring material from the zinc vessel. The platform is provided with an oval wooden ring that serves as a cushion to help make the skull stand upside down over the platform when receiving the measuring material through the foramen magnum. The height of the whole stand is 56 centimeters, just high enough to accommodate underneath it the graduated cylinder of 2,000 cubic centimeters capacity. The distance of the wooden platform from the lower surface of the zinc vessel is 23 centimeters, leaving enough space between them to hold the skull in place beneath the zinc vessel.

We have used the zinc vessel throughout the whole series of volumetric measurement of the skulls. It has been invariably employed in filling both the skull and the cylinder, whether with or without shaking, and for all the materials that we have employed in the measurements.

To measure the capacity of a skull, about 2 liters of the measuring material are poured into the zinc vessel with its outlet closed. The skull is placed upon the wooden platform, beneath the vessel, and made steady by the oval wooden cushion placed underneath the calvarium. The skull is made to stand with its base directed upward and in the horizontal plane, and the foramen magnum exactly opposite the funnel outlet. When the type of measurement to be followed is without shaking, the cranium is filled carefully with the measuring material by opening the outlet of the funnel; that is, by pushing the traplike device, until the cranial vault is entirely filled. The moment when the vault is nearly filled is closely watched for so as to close the funnel opening synchronously with the complete filling of the cranium. If this is not done accurately, there is either an overflow or a little space on the top is left vacant. In the latter case more of the material is allowed to flow slowly until the vault is completely full, and in the former case the excess is carefully removed by means of a tin spatula. In every instance the measurement that

we consider full is that in which the measuring material reaches to the rim of the foramen magnum. The filled skull is set aside for a while. The material remaining in the vessel is then allowed to flow out completely into a receptacle. The outlet of the funnel is again closed. The contents of the skull just set aside are then poured out completely into the vessel. The graduated cylinder having a capacity of 2,000 cubic centimeters is placed below the vessel with the mouth directly underneath the funnel outlet, the platform in this case is folded down through the release of two side hooks, to accommodate the cylinder. The material in the vessel is then allowed to flow into the cylinder, thus providing for its passage through the same outlet and subsequently possessing the same degree of flow through the opening into the cylinder. When all the measuring material has flowed out, the cylinder is removed slowly without jerking, and by means of a light wooden disk with a handle the uneven surface of the material in the graduate is slowly leveled without exerting any pressure on it. This is done so that the right reading can be made. The reading is recorded, and the volume indicated in the graduated cylinder is taken to express the cranial capacity of the particular skull just measured for the series without shaking.

The method that was followed for the series with shaking is essentially similar to that just described as far as the filling of the skull is concerned. The fundamental difference is the application of mechanical force, shaking or pounding, to insure a uniform packing of the measuring material in the cranial vault, on the one hand, and in the graduated cylinder on the other.

To insure a good and uniform packing of the measuring material, we have resorted to shaking, dropping, and hammering the cranium and the measuring cylinder. These are followed and applied systematically with a certain definite number of times for each process and are done in as uniform a manner as it is possible to regulate and control. The cranium that is being measured is only halfway filled with the measuring material at first. It is then removed from the platform below the zinc vessel and shaken ten times from side to side. It is held above a table padded with rubber about 7 millimeters thick, and from a distance of approximately 2 centimeters it is dropped to the rubber pad five times. It is transferred to the platform again to receive more of the measuring material, until it is full. Thence it is removed again to the table and shaken vigorously from side to side for about twenty times. It is then hammered around with a wooden hammer that is padded with rubber at each end.

More of the material is now and then added to the contents by means of a large spoon until there is observed no more appreciable descent or settling of the measuring material. The hammering of the skull is applied at the two temporal regions, at the two malar bones, and over the occipital prominence, the hits beng delivered several times over each of these places. The skull is again dropped to the table five times from the same distance as before. There is usually observed, at this last procedure, no more sinking of the measuring material in the vault. If more space is created through this last maneuver, the skull is again hammered for about ten times and is dropped several times further until no more settling is seen; meanwhile, a little more of the material is added during the process. It will be observed that at this time only very little material need be added for the complete filling of the vault to the rim of the foramen magnum.

The material in the skull is then transferred to the empty zinc vessel for its retransfer through the funnel into the graduated cylinder for volumetric determination. The measuring material is transferred and packed into the cylinder by the same process as that followed in filling the cranium. The same maneuvers and degree of applying the shaking, the hammering, and the dropping are strictly followed. To avoid the breaking of the glass cylinder that has to undergo this treatment, we have padded its bottom with rubber taken from an old automobile inner tubing and we have placed two wide rubber bands around the two levels of the cylinder where hammering is applied. We have, besides, applied adhesive-plaster ribbon, an inch wide, around it at the upper end near its rim, to minimize the vibration of the cylinder produced by the hammering and dropping that caused the breakage of some of our cylinders in the early stage of our experiment. Just as in the filling of the skull, only one-half of the measuring material is admitted at first so that the packing is partially performed at first as was done in the skull. The final reading of the volume of the material in the cylinder is made after the last procedure of applying mechanical force is finished, when there is no more appreciable settling of the material. The figure given in the reading is taken as the cranial capacity of the particular skull used, for the series with shaking.

Three kinds of materials have been employed by us in measuring the cranial capacity of our series; namely, sand, seed, and shot. The sand used has been passed twice through a sieve having 60 meshes to the inch and openings of 0.0087 of an inch.

The bronze sieve used for this purpose was manufactured by The W. S. Tyler Company of Cleveland. The seed employed is white mustard seed which has been carefully selected and cleansed of its impurities. The shot is size 8 with 2.2 millimeters diameter. This shot was carefully examined as to its uniformity in size from time to time, and substitution was made at definite intervals to insure uniformity in diameter, avoiding thereby the reducing effect of the wear and tear on the shot from repeated use.

Other necessary precautions, as advised by Hrdlička, have been carefully observed in the use of the various measuring materials, to insure good and uniform results. In all the cases, the orbits were stuffed with absorbent cotton before the measuring was done; likewise, the inside of the cranium was examined in all instances for projections, abnormalities, or foreign bodies that might have affected the capacity determination of the brain case.

COMPARATIVE STANDING OF RESULTS OBTAINED FROM MEASUREMENTS WITH SHAKING AND WITHOUT SHAKING

One of the several objects we have in view in following the present study is to find out which kind of technic among those that we have used would show the nearest correct measurment of the cranial capacity; that is, which of the various results would contain the least error or variation. We thought of comparing primarily the various results of measurements obtained from the method without shaking and of comparing the result from this, in a parallel manner, to the results of a similar comparison of the various measurments obtained from the method with shaking. In our file cards of records of findings we have the following items of values of cranial capacity:

Method without shaking:

1, Volume in sand; 2, volume in seed; 3, volume in shot.

Method with shaking:

1, Volume in sand; 2, volume in seed; 3, volume in shot.

We compared the maximum, medium, and minimum records of cranial capacities obtained from the method without shaking in each case, irrespective of the kind of measuring material used, for a group of twenty cases selected at random, to the average cranial capacity of each case. The object in view is to discover the extent of variation between the maximum, medium, and minimum capacity recorded for each particular skull in relation to its mean capacity record. Under this procedure we obtained, in the group without shaking, the results in Table 3. This table

shows the existing variations of 47, 40, and 39 cubic centimeters from the mean by the maximum, medium, and minimum records, respectively. These variations range from 3.28 to 2.73 per cent from the mean average under this method.

Comparing in the same manner the maximum, medium, and minimum records of cranial capacity as obtained from the method with shaking in each case of the same twenty cases presented above, we derived Table 4. This demonstrates the existence of differences amounting to 25, 24, and 20 cubic centimeters, respectively, from the mean capacity value of the group in the method with shaking. These variations range from 1.92 to 1.53 per cent only.

TABLE 3.—*Degree of variation of measurements in the method without shaking.*

From the maximum.	From the medium.	From the minimum.	From the maximum.	From the medium.	From the minimum.
130	46	140	66	13	80
63	33	3	6	6	25
40	36	54	53	192	40
26	12	40	10	38	6
20	28	30	66	53	35
66	80	13	6	43	33
60	40	73	80	23	26
113	20	33	13	23	40
36	13	20	40	33	40
33	16	20	10	53	26
Average			[a] 47	40	[b] 39

[a] 3.28 per cent. [b] 2.73 per cent

TABLE 4.—*Degree of variation of measurements in the method with shaking.*

From the maximum.	From the medium.	From the minimum.	From the maximum.	From the medium.	From the minimum.
40	33	13	13	26	13
66	26	36	20	60	33
26	6	13	26	6	33
20	10	40	20	33	0
13	10	6	26	26	13
26	26	0	13	33	46
26	13	13	13	33	13
26	6	6	20	26	33
10	33	40	6	20	13
53	23	6	40	46	26
Average			[a] 25	24	[b] 20

[a] 1.92 per cent. [b] 1.53 per cent.

The findings shown in Tables 3 and 4 indicate that the measurements derived from the method with shaking differ from one another in a much lower degree than those obtained from the method without shaking. The variation existing from the minimum to the maximum in the former method ranges from 1.53 to 1.92 per cent, whereas in the latter it ranges from 2.73 to 3.28 per cent. In actual volumetric values these are 20 to 25 cubic centimeters divergence for the method with shaking and 39 to 47 cubic centimeters for that without shaking.

It can be safely concluded from this that the method with shaking offers in our hand less error or variation in the measurement. This conclusion seems to be fairly reasonable in view of the fact that, although we have followed a technic that will obviate as much as possible too much deviation by making the method mainly mechanical, yet in the method without shaking there seem to be more chances for variation than in the method with shaking. In the latter the mechanical influences are carried out to such an extent that the possibility of variation is very much narrowed down. The application of mechanical force has helped to minimize deviation due to the fact that the limit of possibility for either the vault or the cylinder to accommodate more measuring material is much lessened, unlike that in the method without shaking where there is less control on this possibility.

In this connection, it is of interest to mention the findings and opinions of some of the pioneer workers on craniometry regarding the extent of divergence they obtained in the capacity determination of the cranial vault. Welcker, in his account, claimed that he recorded a divergence in the determination of capacity of only 15 cubic centimeters when he himself made the observations on the dry-material method that he devised. Bartels, on the other hand, mentioned that he could not accept this narrow limit of divergence, that in his work he obtained a divergence of 40 cubic centimeters. Broca, with the use of the shot method, found that he could not get a difference or variation less than 40 cubic centimeters between successive determinations. In the use of the glass-perle method, Torok claimed that he could obtain an accuracy in the measurement of within 7 cubic centimeters divergence. Russel estimated his variation with the shot method as 16 cubic centimeters, and he claimed that in the direct water method this is reduced to 8 cubic centimeters.

With the special method devised by Hrdlička, wherein the mechanical procedure is much emphasized, and which is carefully followed in the present work, it has been claimed that with careful practice it should give a variation of generally less, and never more, than 15 cubic centimeters. We are frank to say that we are still a little way off from the divergence reported for Hrdlička's method. Even with the method with shaking that we have followed, the method that apparently gave in our hands the best result, we obtained a divergence of 20 to 25 cubic centimeters, some 5 to 10 cubic centimeters more than the divergence reported by Hrdlička. We probably have to admit that we lack the necessary experience in this kind of investigative work.

We have worked out the frequency distribution of our cases, both from the results of the method without shaking and those with shaking. There is found a shifting of the greatest frequency from the slightly higher values in the method without shaking to those with lower values in the method with shaking. The cranial capacity that we have obtained from the former method is thus comparatively larger than that derived from the latter method, as shown in Tables 5 and 6 of frequency distribution.

TABLE 5.—*Frequency distribution of cranial capacity in the method without shaking.*

Capacity.	Frequency.	Percentage.	Capacity.	Frequency.	Percentage.
cc.			*cc.*		
1,051–1,100	1	0.23	1,451–1,500	71	16.36
1,101–1,150	1	0.23	1,501–1,550	55	12.67
1,151–1,200	6	1.38	1,551–1,600	27	6.22
1,201–1,250	11	2.53	1,601–1,650	15	3.46
1,251–1,300	38	8.76	1,651–1,700	12	2.76
1,301–1,350	44	10.14	1,701–1,750	7	1.61
1,351–1,400	61	14.06	1,751–1,800	1	0.23
1,401–1,450	84	19.36			
			Total-----	434	100

It is seen from Table 5 (method without shaking) that the frequency distribution of the cranial capacity begins at 1,201 cubic centimeters, from where it follows a rise that is rather abrupt to between 1,401 and 1,450 cubic centimeters. Thence it starts to drop gradually to between 1,651 and 1,700 cubic centimeters. It is also demonstrated in the table that between the capacities of 1,401 and 1,500 cubic centimeters there is com-

prised 35.72 per cent of all the cases, and that between 1,351 and 1,550 cubic centimeters the number of cases included is 62.45 per cent. These points are better illustrated in the curve of frequency distribution in fig. 4.

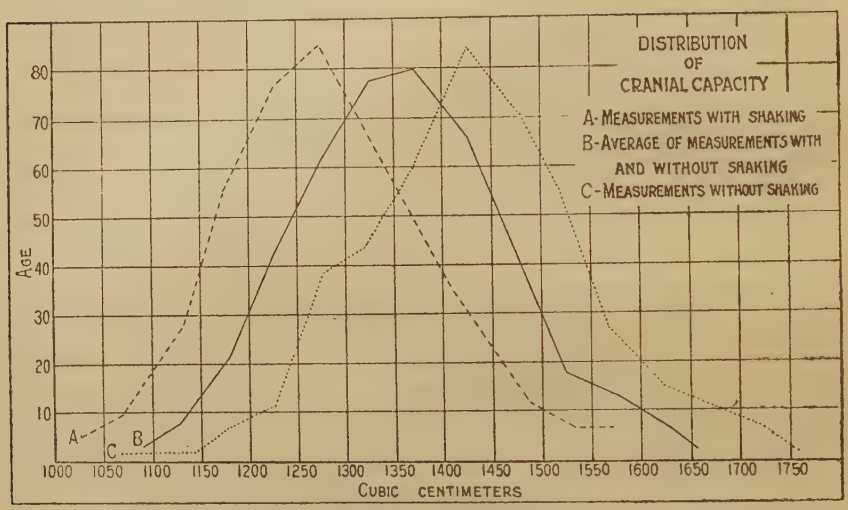

FIG. 4. Curves of frequency distribution of cranial capacity from three measurements: A, with shaking; B, average of with shaking and without shaking; C, without shaking.

TABLE 6.—*Frequency distribution of cranial capacity in the method with shaking.*

Capacity.	Frequency.	Percentage.	Capacity.	Frequency.	Percentage.
cc.			*cc.*		
1,001–1,050	5	1.15	1,351–1,400	47	10.80
1,051–1,100	10	2.30	1,401–1,450	34	7.81
1,101–1,150	27	6.21	1,451–1,500	12	2.76
1,151–1,200	55	12.65	1,501–1,550	7	1.61
1,201–1,250	76	17.47	1,551–1,600	7	1.61
1,251–1,300	85	19.54			
1,301–1,350	70	16.09	Total...	435	100

Table 6 (method with shaking) demonstrates that the frequency distribution begins at 1,051 cubic centimeters from where the number of cases rapidly rises and reaches its maximum frequency at the capacity between 1,251 and 1,300 cubic centimeters. From this point it gradually descends to the capacity between 1,451 and 1,500 cubic centimeters. Between the capacities 1,201 and 1,300 cubic centimeters the number of cases comprised is 37.01 per cent, while between those of 1,151

and 1,350 cubic centimeters there are included 65.75 per cent of all cases. The course of the curve of frequency distribution for this method is shown in fig. 5.

The parallel condition of the curve of distribution found for the two methods is demonstrated in fig. 4 together with the curve of average values of the cranial capacity derived from both.

So as to study the comparative standing of the frequency distribution of the cranial capacity as obtained from the method with shaking as measured by the three different materials; namely, sand, seed, and shot, we have also traced the results of each

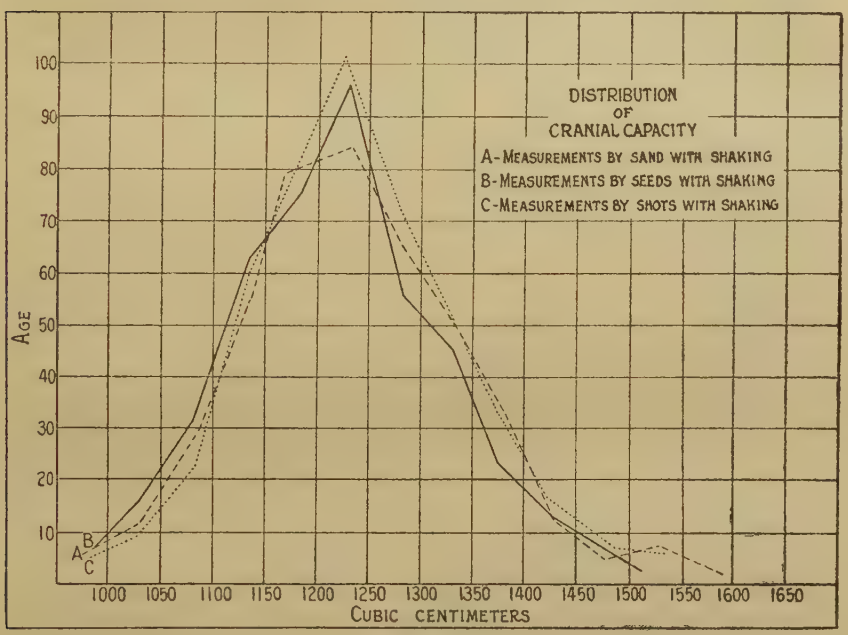

FIG. 5. Curves of frequency distribution of cranial capacity from the method with shaking: A, as measured by sand; B, as measured by seed; C, as measured by shot.

one and placed them together in fig. 5. Under this method with shaking, there is found with the sand material a frequency of 37.36 per cent between the capacities of 1,201 and 1,300 cubic centimeters, and 65.16 per cent between those of 1,151 and 1,350 cubic centimeters. With the seed for measuring material there is found a frequency distribution of 39.24 per cent for the capacities between 1,201 and 1,300 cubic centimeters, and 66.30 per cent between 1,151 and 1,350 cubic centimeters capacity. In the measurement with shot the frequency distribution is 35.77

per cent between 1,201 and 1,300 cubic centimeters and 66.04 per cent between 1,151 and 1,350 cubic centimeters capacity.

If the results are placed together side by side it will be seen that under the method with shaking there exist only small differences in the frequency distribution between the findings obtained from the three materials used in measuring. The differences observed are certainly much less than the difference met with in comparing the averaged findings derived from the method without shaking and that from the method with shaking. The above points are brought out clearer in studying the relative standing of the different maximum frequencies in Table 7.

TABLE 7.—*Maximum frequency distribution of cranial capacity in the various methods of measurement.*

Method.	Capacity.	Percentage frequency.
	cc.	
Without shaking (by three materials)	1,401–1,500	35.72
Do	1,351–1,550	62.45
With shaking (by three materials)	1,201–1,300	37.01
Do	1,151–1,350	65.75
With shaking:		
By sand	1,201–1,300	37.36
By seed	1,201–1,300	39.24
By shot	1,201–1,300	35.77
By sand	1,151–1,350	65.16
By seed	1,151–1,350	66.30
By shot	1,151–1,350	66.04

We have also employed the three materials for measuring the cranial capacity in the method without shaking, but we did not arrange the data gathered for frequency distribution. It is believed that the variation in the results from this method is considerably wider than that from the method with shaking as expressed in the previous findings for this method, so that it is not deemed important to present here their frequency distribution. The frequency distribution of the averaged data from the three measurements in the method without shaking, as given in the previous paragraphs, is believed sufficiently clear to show some important points on the capacity distribution of cases under this method.

MEAN VALUES OF CRANIAL CAPACITY

The mean values of cranial capacity met with in this series show a certain extent of variation in the different methods of measurements. This is particularly noticeable between the

method with shaking and that without shaking. The mean capacity obtained from the method without shaking is 1,423 ± 3.67 cubic centimeters, with a minimum of 1,060, and a maximum of 1,762. The unit difference in this method without shaking reaches an amount of 702 cubic centimeters. From the method with shaking there was obtained a mean of 1,301 ± 3.50 cubic centimeters, with a minimum of 1,016 and a maximum of 1,597, showing a unit difference of 561 cubic centimeters.

It is seen from the above figures that between the means from the two methods of measurement there is found a difference of 122 cubic centimeters. This difference amounts to about 8 per cent of the average value of the mean cranial capacity derived from both methods, which is 1,362 cubic centimeters.

It does not seem easy to decide from the mean values given above which one should be taken to represent the cranial capacity of the series of skulls now dealt with. Judging from the findings on the degree of divergence existing between the method with shaking and that without shaking, from the extent of deviations found between the results of measurements by the three materials (sand, seed, and shot) and from other indications that we have met during the process of working, we are very much inclined to consider the mean value derived from the method with shaking as the one probably nearest the actual capacity and that this can be preferably taken to represent the capacity of the present series of skulls. It is to be remembered that the series with shaking offered a divergence of only 1.53 to 1.92 per cent, while that without shaking gave a divergence of between 2.73 and 3.28 per cent. There is also to be considered, although not as important and as noticeable as the previous points, the relative standing of the probable error of each method. In the former the probable error is ± 3.67; in the latter, ± 3.50.

We have also studied in this connection the comparative standing of the means of the cranial capacity as measured by sand, seed, and shot. The object of this was to discover which of the three materials might have offered the most preferable result in deciding the mean cranial capacity for the present series. Under the method without shaking the means found are 1,468 cubic centimeters with sand, 1,429 cubic centimeters with seed, and 1,415 cubic centimeters with shot. It is seen that between the means with sand and with seed there is a difference of 39 cubic centimeters and between those with seed and with shot a difference of 14 cubic centimeters. The greatest difference

is that between sand and shot and is 53 cubic centimeters. The means obtained from the method with shaking show certain parallel results as those obtained from the method without shaking in reference to the use of three materials. Of these the one showing the greatest value under both methods is that recorded by sand. The means obtained from the method with shaking are 1,331 ± 3.81 as recorded by sand, 1,291 ± 3.38 as recorded by seed, and 1,282 ± 3.34 as recorded by shot. In the latter method the differences are not great, and the degree of probable error presented does not vary to so great an extent as to be of value in deciding which mean should be given preference. These findings do not seem to offer, as they are, definite choice on the mean cranial capacity. The probable errors presented revolve around very close values, and the differences are in fact negligible as far as choice of mean cranial capacity is concerned.

In the method without shaking and with the use of sand, seed, and shot we have found that the means are invariably greater than those obtained from the method with shaking. These are given in Table 8, compared with the means from the method with shaking. The purpose of the comparison is to see the relative difference between them with the idea of determining which material gave, in the process of measurement with shaking, the most-reduced capacity value.

TABLE 8.—*Mean values of cranial capacity as measured by three materials in the methods with and without shaking and their differences.*

Method.	Measured by sand.	Measured by seed.	Measured by shot.
	cc.	*cc.*	*cc.*
Without shaking	1,456	1,414	1,401
With shaking	1,331	1,282	1,291
Difference	125	132	110

This comparison indicates that there exists the least amount of difference in the measurements with shot between the methods with shaking and without shaking. This difference is 110 cubic centimeters; with sand it is 125 cubic centimeters; and with seed it is 132 cubic centimeters. This most likely means that with shot as the measuring material there occur less variations in the result, and that it afforded more-uniform results of measurement in the process of shaking. This is probably explained by the fact that as measuring material shot, properly calibrated and selected, possesses much more uniform size than

either seeds or sand and that in the forced filling of the cranial vault in the method with shaking each grain of shot could occupy a space of only its size giving thereby uniform size of void spaces, hence the more-uniform or less-variable volumetric result. Sand probably comes next to shot in point of uniformity in size of the individual grains. The sand used, as described before, is passed twice through a sieve of 60 meshes to the inch, and the grains are fairly uniform in size. Because of the fineness of the grains of sand, however, shaking of the material in the process of measurement with shaking will very likely give more variation than when shot is used, as the smallest grains of sand can still occupy the intervening void spaces between the larger grains. It is most likely due to these facts that the amount of difference shown between the various measurements with sand is greater than that with shot. In the case of seeds the variation is greater than that with sand or shot. This we explain is due to the lack of uniformity in the size of the grains of mustard seed used and that the void spaces are very irregular. Even with careful selection, the seeds are apt to be of various sizes and the result of volumetric measurement is in all probability more variable.

The tabulated summary of the mean cranial capacity derived from the various methods that have been followed is presented in Table 9. Included also are the probable errors, and the minimum and maximum records of cranial capacity with the unit differences existing between them. This also gives the mode and the median cranial capacity found for the various methods and materials.

TABLE 9.—*Summary of the mean, minimum, and maximum values of cranial capacity, probable errors, etc., of different measurements.*

Method.	Mean cranial capacity.	Probable error.	Minimum cranial capacity.	Maximum cranial capacity.	Unit difference.	Mode cranial capacity.	Median cranial capacity.
	cc.	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*
Without shaking (average of three materials)	1,423	3.67	1,060	1,762	702	1,426	1,433
With shaking (average of three materials)	1,301	3.50	1,016	1,597	581	1,276	1,277
With shaking (measured by sand)	1,331	3.81	1,005	1,640	635	1,282	1,280
With shaking (measured by seed)	1,282	3.34	1,010	1,560	550	1,281	1,270
With shaking (measured by shot)	1,291	3.38	1,010	1,600	590	1,277	1,280

In regard to the existence, in the actual findings, of greater capacity value derived from the method without shaking as compared with that obtained from the method with shaking, we desire to give in brief the following points that we judge must have been the contributory factors.

The differences observed are believed to be most probably due to the employment of the graduate cylinder for the volumetric determination of the measuring materials in both methods and to the dissimilarity between the form, the surface, and other qualities of the cranium and the graduate. The columnar form, the uniformity and glassy smoothness of the inside surface, and the greater height of the cylinder seem to be important factors that must have effected the differences in the results. The cranial vault on the other hand has irregular projections and a rough contour with the vertical dimension only one-third of that of the cylinder. It can be easily imagined that the material used in the measurement must have been lodged and packed inside the cranial vault quite differently from that in which it is found in the graduate cylinder. In the method without shaking the filling of the graduate by the material must have been unequal in the whole column of the material, even considering that the filling comes from the same standard funnel outlet. The density of the lower portion must have been more than that of the upper levels; that is, the density of any level in the column is inversely proportional to the height of the level. In the method without shaking the filling of the spherical vault of the cranium, with a height only one-third that of the cylinder, must have taken place more uniformly and the density throughout must have been more nearly uniform than in the cylinder. The same material, when transferred to the cylinder, must have assumed a little greater volume than it had in the cranium due to the gradual reduction in density from below upward in the cylinder. Under the method without shaking the void spaces present between the grains of measuring material in the cranium as well as in the cylinder, must have been greater in totality than the void spaces in the material under the method with shaking. The latter condition, associated with the former physical state of the measuring material, wherein there is unequal density in the cylinder, would seem to speak for the actual showing of greater volumetric capacity in the cylinder in the process of measurement without shaking. It can be reasonably expected, therefore, that the measuring material will assume in all cases a little larger volume in the cylinder under

the method without shaking than it will show under the method with shaking, even considering that the filling of the cranium by a given material is identical for both methods.

In the method with shaking, on the other hand, it is believed that the volume of the measuring material in the cranium when transferred to the cylinder and subjected to the same procedure of shaking and pounding, would not very likely assume increase in volume in the latter; on the contrary, it is believed it will suffer a slight reduction in volume. The measuring material cannot assume larger cubage in the cylinder under this method as the application of mechanical force will tend to equalize the volume in the cranium as well as in the cylinder, as the void spaces that are present between the grains of measuring material will be reduced to their lowest limit and effect thereby a more uniform packing inside them, notwithstanding the differences in size and in form of the two. The assumption that the volume of the material in the cylinder might have suffered further slight reduction in volume is thought due to the fact that the inside of the graduate has a much more uniform contour and a smoother surface than the cranium and that the material contained in the former might assume such a compactness as to reduce both the number and the size of the void spaces in the cylinder to a further extent than in the cranium, causing thereby a little lower volumetric reading under the method with shaking.

Under the above-described conditions of measurement it is believed that, taking everything into consideration, including other points and findings met with in the course of this work, the expression of cranial capacity that will approach nearest the correct or actual capacity of the crania is the average value calculated from the results derived from the use of the three different measuring materials under the method with shaking. Under this consideration the cranial capacity of this series will be 1,301 cubic centimeters, with the standard deviation of 108.58 and probable error of $\pm$ 3.50.

We are presenting (Plates 2 and 3) the pictures of crania for both the male and the female groups of our series that possess the maximum and minimum cranial contents as met with in our process of measurement. Figure 3 represents the male cases, one with the highest cranial capacity of 1,655 cubic centimeters (case 544); and the other possessing a minimum capacity of 1,083 cubic centimeters (case 350). These cubages given here are based on the mean values of records from all

the three materials used in measurements under the method with shaking. Figure 4 represents two female crania possessing a maximum capacity of 1,480 cubic centimeters (case 134), and a minimum cranial contents of 897 cubic centimeters (case 480). The pictures show the frontal, lateral, and superior views. The other data of these four cases of crania together with various cranial measurements derived from them are given in Table 10.

TABLE 10.—*Cases with maximum and minimum cranial capacities and their cranial measurements.*

No. of cranium.	Sex.	Age.	Cranial capacity.	Maximum antero-posterior diameter.	Maximum transverse diameter.	Basio bregmatic height.	Auriculo bregmatic height.	Sagital arc.	Transverse arc.	Horizontal circumference.
		Yrs.	*cc.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
544	M	31	1,655	178	153	145	126	390	345	520
350	M	48	1,083	159	129	132	113	343	299	460
134	F	45	1,480	183	138	132	114	367	312	511
480	F	46	987	163	128	127	106	327	282	469

FEMALE CRANIA

The number of female crania in the present series is small, and we feel skeptical in reporting the measurements obtained from them. The twenty-two cases are given here for what they are worth, together with their cranial capacities as obtained from the average of the three materials employed under the method with shaking.

TABLE 11.—*Records of female crania.*

Serial No.	Case No.	Age.	Cranial capacity with shaking.	Serial No.	Case No.	Age.	Cranial capacity with shaking.
		Yrs.	*cc.*			*Yrs.*	*cc.*
1	480	46	987	12	91	51	1,215
2	629	40	1,015	13	342	95	1,225
3	355	76	1,032	14	466	20	1,239
4	340	100	1,048	15	215	34	1,240
5	165	70	1,075	16	431	89	1,248
6	359	57	1,097	17	531	65	1,255
7	503	15	1,107	18	242	33	1,274
8	291	43	1,123	19	129	80	1,283
9	90	80	1,205	20	248	25	1,326
10	619	80	1,205	21	401	48	1,341
11	441	35	1,209	22	134	35	1,480

The minimum capacity found for the female skulls is 987 cubic centimeters, and the maximum capacity recorded for them

is 1,480 cubic centimeters, showing a unit difference of 493 cubic centimeters. The mean capacity obtained is 1,192 cubic centimeters, with a standard deviation of 118, a probable error of ±16.86, and a coefficient of variation of 9.88.

Comparing the above values with those obtained from the male group of our series, it is observed that the male cranial capacity is superior by 96 cubic centimeters between their minimum records, by 209 cubic centimeters between their mean values, and by 175 cubic centimeters between their maximum records. These amount to 8.86, 16, and 10.57 per cent, respectively. Table 12 shows these differences.

TABLE 12.—*Comparative table of male and female cranial capacity.*

	Cranial capacity.			Standard deviation.	Probable error.
	Minimum.	Mean.	Maximum.		
	cc.	*cc.*	*cc.*	*cc.*	*cc.*
Male	1,083	1,301	1,655	108.58	3.50
Female	987	1,192	1,480	118.00	16.86
Difference	96	209	175	----------	----------

It may be interesting in this connection to see the comparative standing of the male and the female physical measurements and their correlation with their cranial capacity values. We can only present here the measurements found by Nañagas for the adult Filipino students of the University of the Philippines, as no comprehensive data from a more-extensive portion of the population have been reported. They are presented only for a cursory comparison and need not be taken with definiteness. The male stature is 163 centimeters with a body weight of 50.6 kilograms. The female measurements are, respectively, 152 centimeters and 43.2 kilograms. The difference in stature between the two sexes amounts to 6.7 per cent, and the difference in body weight is 14.8 per cent. It is seen that there is considerable discrepancy between the records of cranial cubage (16 per cent) and that of stature (6.7 per cent). However, the difference in cranial capacity between the two sexes approaches their difference in body weight, the latter amounting to 14.8 per cent. The presence of the former discrepancy we cannot very well explain; it may be due to the limited number of female cases represented. The difference between the cranial capacity on the one hand and the body weight on the other is very slight.

COMPARATIVE STUDY ON THE CRANIAL CAPACITY OF VARIOUS CASES

It does not appear fair to follow up a comparison of the various results and findings as obtained from different sources and authors with those of our data when the methods employed in different types of cranial measurements do not exactly coincide and where the effects of personal equation are as variable as are the methods used. Nevertheless, it is interesting in some way to get an idea of the gross comparative standing of the different races on this question of cranial cubage, even on a provisional and introductory manner only, for the time being, until more-definite and comprehensive data are gathered which will be more scientifically comparable.

In presenting our comparison in this paper it is desired to mention frankly that we are doing it with the full knowledge that our comparison will be incomplete in some ways and it will probably be not as nearly ideal as we would like to have it. In a comparison of data on an important measurement like the cranial capacity of man, there should invariably be presented also the records of their stature, body weight, build, constitution, and several other physical records that have some direct relationship with the cranial capacity. These measurements enumerated cannot be presented together with the fundamental measurement taken up in this paper as it is not within our reach, at the present time, to gather and closely scrutinize comprehensive data on physical measurements of other races.

We have gathered but limited data on cranial cubage of other races from the literature locally available. These data were reported by various authors from different numbers of cases; some with the technic of measurement described, others with their methods not given.

The comparisons are given mainly in tabulated form, and only little attempt is made in discussing the degree of comparative peculiarities of our cranial capacity with those of other races as reported by foreign authors. Similarly, we do not feel justified in drawing any definite conclusion in this paper as we regard this as a mere opening study on the craniometry and anthropometry of the Malays as represented by the Filipinos in this region. In considering a fundamental measurement like the cranial capacity we realize that there should be proper care and patience, and due time given for additional work before drawing conclusions; and that in this particular point of com-

parison we feel that we are only justified in the present instance to consider our findings as temporary.

In Table 12 are represented some fairly complete records of cranial capacities of the American, German, Negro, Aino Japanese, Nagada, and our Filipino group. The foreign data were obtained from the work of Todd on the Americans (white and negro) and as quoted by him for the German, Aino, and Nagada from the work of Pearson; and also for the African Negroes (Batetela and Gaboon) as quoted by him from the studies of Crewdson Benington.

The record of measurement that we are presenting in this tabulation is that derived from the type of measurement obtained with shaking, as this is the capacity, according to our judgment, that probably approaches nearest to the correct or actual volumetric contents of the series of crania here dealt with, as already pointed out and discussed elsewhere in this paper.

TABLE 13.—*Comparative table of cranial capacity of various races.*

Authors.	Race or stock.	Sex.	Number of cases.	Mean cranial capacity.	Standard deviation.	Probable error.	Coefficient of variation.
				cc.	cc.	cc.	
T. W. Todd	American (white)	Male	167	1,391	117.58	4.34	8.45
Do	do	Female	31	1,231	126.32	10.79	10.25
Do	American (negro)	Male	87	1,350	128.16	6.54	9.50
Do	do	Female	17	1,220	123.96	14.16	10.15
Lea and Pearson	German	Male	100	1,503	116.89	-------	7.77
Do	do	Female	99	1,337	108.73	-------	8.13
Do	Japanese (Aino)	Male	76	1,461	100.60	-------	6.88
Do	do	Female	52	1,307	89.75	-------	6.86
Do	Nagada	Male	69	1,386	104.36	-------	-------
Do	do	Female	98	1,279	94.03	-------	-------
R. C. Benington	African Negro (Batetela).	Male	47	1,343	126.57	8.81	9.42
Do	do	Female	21	1,205	107.68	11.21	8.93
Do	African Negro (Gaboon).	Male	49	1,380	107.69	7.34	7.80
Do	African Negro	Female	43	1,231	126.63	9.20	10.28
J. C. Nañagas	Malay (Filipino)	Male	436	1,301	108.58	3.50	8.33
Do	do	Female	22	1,192	118.00	16.86	9.88

In order to understand better the relative standing of the cranial capacities compared in the above tabulation, it is necessary to quote verbatim from Todd to show certain view points in his comparison. It will help to clarify to some extent the comparative interpretation of findings on the present group.

The German series used by Lee and Pearson are Ranke's Alt-Baieriche collection which may be taken as a series fairly representing the mediaeval

Bavarian population of the country-side. It is a rather homogeneous series. Our own Whites are as heterogeneous as could be imagined for they consist of the human flotsam which has drifted west, some from the British Isles but vastly more from the countries along the North Sea and the Baltic from the Rhine to Riga and the hinterland back to the Danube. I am not absolutely sure that our female population (and by population I mean the material of the laboratory upon which alone our views are built) is the same as the male. There are some features about the females which seem to indicate an older American stock, but the discussion of this problem must be reserved for a future occasion. The consequences of the difference in homogeneity between our material and Ranke's Bavarians will become increasingly evident but the rather striking difference in mean capacity is certainly not due to degree of racial purity. Lee and Pearson give a mean capacity for the male of 1,504 cc.; the mean capacity of our male White material is only 1,391 cc. We have already noted that it is quite proper to compare these two series, having regard to the methods of determination of capacity. The difference in capacity cannot be attributed to difference in technique in this case although it is true that technique has usually been to blame for at least part of the discrepancy between the conclusions of various observers. In the later parts of this work it will become increasingly apparent that we have here a real difference and the origin and production of the difference in capacity will become evident. Between these two series the difference of the means is 113 cc. and the probable error of this difference is 15 cc. Between the corresponding female series the difference of the means is 105 cc. and the probable error 25 cc. There is no doubt therefore about the reality of a fundamental difference between the two groups of crania. Now it is also rather significant that the male Bavarians show a capacity 8.1% greater than our male Whites, and the female Bavarians show a capacity greater by 8.5% than the mean of our female White. Our material is certainly not representative of the average population of the city. It is a shiftless population recruited from the water front, the criminal districts and the underworld. Interpreted in this manner and compared with the average country-side population of old Bavaria it gives a suggestive indication of the effect of the selection of crime, drunkenness, and poverty. We are also impressed with the pronounced influence of selection of one kind or another upon the mean capacity as established by different workers. The startling divergences in mean capacity apparently referring to samples of the same race, which so thoroughly aroused the attention of Welcker and other investigators and have been partly responsible for discouraging work on cranial capacity, are undoubtedly due in part to differences in the sample. This emphasizes the prime importance of sparing no pains to obtain and publish all data respecting the origin of the sample in question and the necessity of studying the probable influences at work in its selection.

Turning to the Negro figures we find an entirely different kind of selection at work. Our material is much more truly representative of the general negro population in America than is the case with our White material. Here we are dealing with a problem, not of crime and moral obliquity, but of misfortune and hereditary disadvantages. In the later communications we shall find ample confirmation for this thesis. If upon general principles which cannot be fully discussed at this juncture, the

point be conceded, we are enabled further to consider the relation of our Negro series to the various African groups hitherto studied. I have expended a good deal of effort with quite unsatisfactory results upon the problem of the precise African origin of our Negro population. Various scholars who have devoted thought to the origin of the American Negro have been able to produce merely scanty and comparatively worthless evidence. Hawkins' journals give little help and I am not at all clear as to from how far along the coast of West Africa and how far into the interior our Negroes came. The more I think of this problem, however, the less do I come to value the result of the investigation. There is no doubt that a great mixture of native types and races had taken place in the very areas from which of necessity our Negroes must have come. In the beginning the American Negro undoubtedly belonged to quite as heterogeneous a group as the Whites who have voluntarily followed him to these shores during the past century. The physical characters of our Negroes show plainly that they came from West Africa and not from North Africa or from far south of the equator. A much more significant question, and one more promising of settlement than original African areas, is the condition of the Negroes after arrival in the West Indies. One would like to ascertain how greatly they mingled their blood with that of other races especially of the Whites, and again, what effect contact with the White man or, if one please so to term it, civilization, has had upon their physical characteristics. On another occasion I hope to take up these points seriatim but this is too early in the investigation to deal with the problem usefully.

* * * Instead of a marked difference between the means such as we have found in the case of the Whites, our Negro mean falls between those of the two Negro series now being compared. The difference between the means of our material and the Batetela males is only 6 cc. and the error of this difference 23 cc. For the Gaboon and our males the difference in mean capacity is 51 cc. but the probable error of the difference is 21 cc. The corresponding differences in the means of the females are 15 cc. for the Batetela with an error of 38 cc., and the difference of 10 cc. for the Gaboon with an error of 36 cc. In no case therefore is there any significant difference. Not one of the series is really large and the female groups are merely included to complete the suggestiveness of the survey. It is apparent that all these groups of crania come essentially from the same people, that our series is fairly representative of the population at large, and that contact with the White man, and even the formation of hybrid material, over three hundred years has not in the slightest obscured the plainly Negro characters. The extraordinary similarity between our Negro males and the Batetela males in mean capacity, standard deviation and coefficient of variability cannot pass unnoticed. We shall see later that the American Negro has longer and rather higher head than the Batetela and in these respects approaches the Gaboon group. Therefore the close similarity with the Batetela in the table must not be over stressed; it is interesting but not necessarily significant.

One may be surprised to observe the degree of relative standing of the cranial capacity value of the Filipino group here presented as compared with those of the other races.

Under a more-careful consideration, however, one will easily understand that the surprise created at first sight is mitigated by the parallel study of their other fundamental physical characteristics. We have in mind those of stature, body weight, build, and the relative size of the heads. These basic physical differences between races must necessarily be considered, as we have already emphasized in the first part of this paper, if a proper manner and a fair type of comparison is to be followed.

It can be seen that our cranial capacity, compared with that of the American white, as reported by Todd, shows a lower difference of 90 cubic centimeters, amounting to 6.91 per cent. This difference is only expected, as there actually exist considerable differences between the body sizes and build of the two people. In stature alone the American white surpasses the Filipino, the former being under the classification of the "high stature" whereas the latter is known to belong to the "stature below the average." According to our available literature, their stature is given around 175 centimeters, their body weight around 68 kilograms, and their build about 22. Those of the Filipino, on the other hand, as found by Nañagas, are respectively around 163 centimeters, 50 kilograms, and 19. The Filipinos, or the Malays, being a smaller type of people, would have a proportionately smaller head measurement.

It is noticed that the difference in stature of the two races falls around 7 per cent, which closely parallels, in degree, their difference in cranial capacity. The difference in body weight, however, is considerably more than that in stature, this reaching around 32 per cent. Body weight is of course a fairly variable body measurement, much more so than stature, and it does not serve as good a point of correlation as the latter in the study of physical developmental conditions of different races. The great difference reported for the body weight is significant of the lower condition of body nutrition among the Filipinos, which has been emphasized repeatedly by the writer in some of his publications. From the greater discrepancy between the body weights on the one hand, and the smaller relative difference in their cranial cubage as herein found between the two, it may be inferred that the cranial-capacity record of the Filipinos is comparatively good and proportionately high; their body weight being very much lower. This signifies also that the Filipinos have poor body nutrition and development and that this condition does not seem to affect their cranial capacity, thus showing once more the rather invariable condition of the

cranial contents, unaffected by the irregular and frequently changing condition of the rest of the body as expressed in body weight.

It should be mentioned in this connection that the present Filipino group under consideration is not representative of the mass of our population. It constitutes mainly the very poor ignorant class of the inhabitants (cases unclaimed from the city morgue), who are prone, through indulgence, to do ruthless and criminal acts for their means of livelihood; or are apprehended by the police authorities for their bad practices through superstitions and ignorance. A great majority of these cases came from the Government penitentiary, as mentioned in the early part of the paper.

Ethnologically, this group is quite homogeneous, all the cases belonging to the Malay stock of our population, although some of them carried an admixture of Mongolian blood. It is to be noted that throughout the whole of Indonesia and Malaysia there exists a considerable admixture of Mongolian blood, derived principally from the Chinese infiltration of these regions, and coming mostly from South China. This was true for several centuries in the past and is going on, to a certain extent, at the present time. This admixture is the commonest type that is observed now among the people inhabiting the Philippines, this is seconded by the Iberian admixture effected by the occupation of the Islands by the Spaniards for a period of more than three centuries.

In regard to the lesser value of cranial capacity demonstrated by our group compared with those of the Negroes, both of America and Africa, it is believed that the physical differences existing between the two kinds of races explain the presence of such collateral difference in cranial cubage. Physically, the Negroes are a much taller and larger race than the Malays. The African Negroes, from which the American Negroes were originally extracted, range in stature from around 170 to frequently more than 180 centimeters; whereas the Filipinos reach a stature of only around 165 centimeters. Such an existing large difference in height will certainly influence the relative values of their cranial cubage. This difference amounts to around 6.8 per cent. In cranial capacity on the other hand the difference amounts to around 3 per cent only between our record and those of either the American or the Batetela Negroes. Our series shows a cranial capacity of 6 per cent less than the Gaboon Negroes.

The above figures show again, according to our judgment, that our cranial capacity does not appear too small in comparison with that of other races when other physical differences are taken into account.

One of the interesting comparisons shown in Table 12 is that of the German Bavarian and that of our group. Both of these series, Bavarian and Malay, are fairly homogeneous in type as far as their racial compositions are concerned. It is significant that there exists a strongly marked difference in cranial capacity between the two. Their mean cranial capacities, 1,503 cubic centimeters for the German and 1,301 cubic centimeters for the Filipino, show a difference reaching 200 cubic centimeters, and amounting to 15.5 per cent more for the Bavarian. This European series, as described by Todd, was derived from a Bavarian population of the country-side. These people must have possessed a medium stature, although this was not described by Lee and Pearson. They must have belonged also to that rather common German type of man possessing a fairly large brachicephalic head frequently met with throughout Prussia. It is only to be expected that this brachicephalic type, with a high cranial index, about 83, must possess a much larger cranial cubage than those of our series. The Malays, as reported by various authors, possess a mean cranial index of around 75.

The difference in stature, although not as prominent as in those of the other races compared, must have something to do with the greater cranial capacity record of the Bavarian over that of our present series. Another point that may be added is the relative degree of cultural level of the two series. The cases composing ours, as mentioned already in the preceeding paragraphs, happened to come from the low, ignorant, and criminal class of our population, which in cultural and educational standing must be far below that of the country-side inhabitants of Bavaria. The German series is a representative homogeneous group, whereas ours, although likewise of homogeneous Malayan blood, is not representative of the great, literate mass of our present-day population.

There is likewise noticed a considerable difference in cranial capacity between the Ainu, the aborigines of Japan, and our series. This amounts to nearly as much as that of the Bavarian record. The mean cranial capacity of the Ainu is 1,461 cubic centimeters, in contrast to the present Malay series of 1,301 cubic centimeters. This difference is 160 cubic centi-

meters, or 12.2 per cent, more than that of our group. It is rather suprising that the Ainu possesses a much higher cranial cubage than the Malay. The Ainus of course are known to possess good physique, having better-developed and heavier-set bodies than the Malays. In stature, however, the two races are almost the same, the reported height of the former is 158 centimeters, whereas the Filipinos possess even the slightly higher stature of 163 centimeters. In cephalic index also they are closely similar; the Ainus have a cephalic index of around 76 as reported by foreign observers.

It has been alleged and confirmed by many ethnologists that although the much-discussed Hairy Ainus are indigent inhabitants of Japan, yet there are enough reasons to consider them as survivors of the remote Asiatic branch of the Caucasian race, and that they are not really Mongolian. What bearing this particular claim has on the higher record of their cranial capacity, as mentioned here, the writer is not in a position to discuss.

In following up the above type of comparison, which is rather superficial we admit, the writer feels somewhat skeptical in employing records from different observers that were derived from measurements taken with varied technics. This point we have already mentioned in the early part of this topic. It is observed that under certain conditions the difference in capacity seems to be attributable to the discrepancy in methods and that the existence of some contradictions between results and conclusions are mainly due to this and other associated factors. We are stating this simply to mention once more that such comparisons, like this one we followed, are only tentative and that whatever conclusions or assertions are made to explain a finding should be taken only provisionally. Of course an ideal way to have a satisfactory comparative study of cranial capacity, or of any other fundamental body measurement, of the different races of people is to have a single well-equipped and properly organized institution for each line of work which will uniformly take care of measuring, compiling, and reporting the data and results gathered from different regions of the world. This kind of institution should be international in scope, and measurements should be undertaken in the field directly with instruments carefully tested and with methods painstakingly studied. Under this seemingly idealistic, but perfectly workable idea we can expect, with greater confidence, many significant results and conclusions on the comparative physical standing of the different races of mankind.

The comparative standing of the female group of our cases with those of the foreign records of cranial capacity can be seen in Table 14 together with the comparison of the male data. We did not discuss the relative standing of the female groups as they more or less follow, in a lower parallel degree, the differences existing between the male series, and thus a similar line of reasoning can be applied in their comparison.

TABLE 14.—*Actual and percentage differences between the cranial capacity of other races and that of the Filipinos.*

Race or stock.	Males.		Females.	
	cc.	*P. ct.*	*cc.*	*P. ct*
American White	90	6.91	40	3.35
American Negro	49	3.76	28	2.43
German Bavarian	202	15.52	145	12.25
Japanese Ainu	160	12.29	115	9.64
Nagada	85	6.53	87	7.34
African Negro (Batetela)	42	3.22	13	0.99
African Negro (Gaboon)	79	6.07	39	2.99

SUMMARY

The total number of crania available for this study is four hundred fifty-eight. Four hundred thirty-six are males and only twenty-two are females.

The geographic distribution of these cases coincides, in frequency, with the degree of the actual thickness of population of the different principal regions of the Archipelago. One unfortunate incidence in this series is the fact that a great majority of them were inmates of the Government penitentiary.

Of the two principal methods of capacity measurement—with shaking and without shaking—the former has given us better results. The results from this type of measurement can be taken, in our opinion, to represent the nearest to the actual capacity of the crania under study.

Of the three materials used for measuring—sand, seed, and shot—the last, when properly calibrated, gives the least variable results. Under the method with shaking, however, all the three materials used showed but slight variations so that the average of the results of the three should preferably be taken to represent the cranial capacity value of the cases.

The maximum cranial capacity found for the male group is 1,655 cubic centimeters, and the minimum is 1,083. For the female group, the maximum is 1,480 cubic centimeters and the minimum 987.

The mean cranial capacity for the male group is 1,301 cubic centimeters, with a standard deviation of 10.858; for the female group, 1,192 cubic centimeters, with a standard deviation of 118.

Comparison is made of the cranial capacity obtained from the present series with those of other races. It was found that in the Filipino it is relatively smaller, falling more or less in direct proportion to the difference in stature and general physique existing among the various races and nationalities.

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ILLUSTRATIONS

PLATE 1.

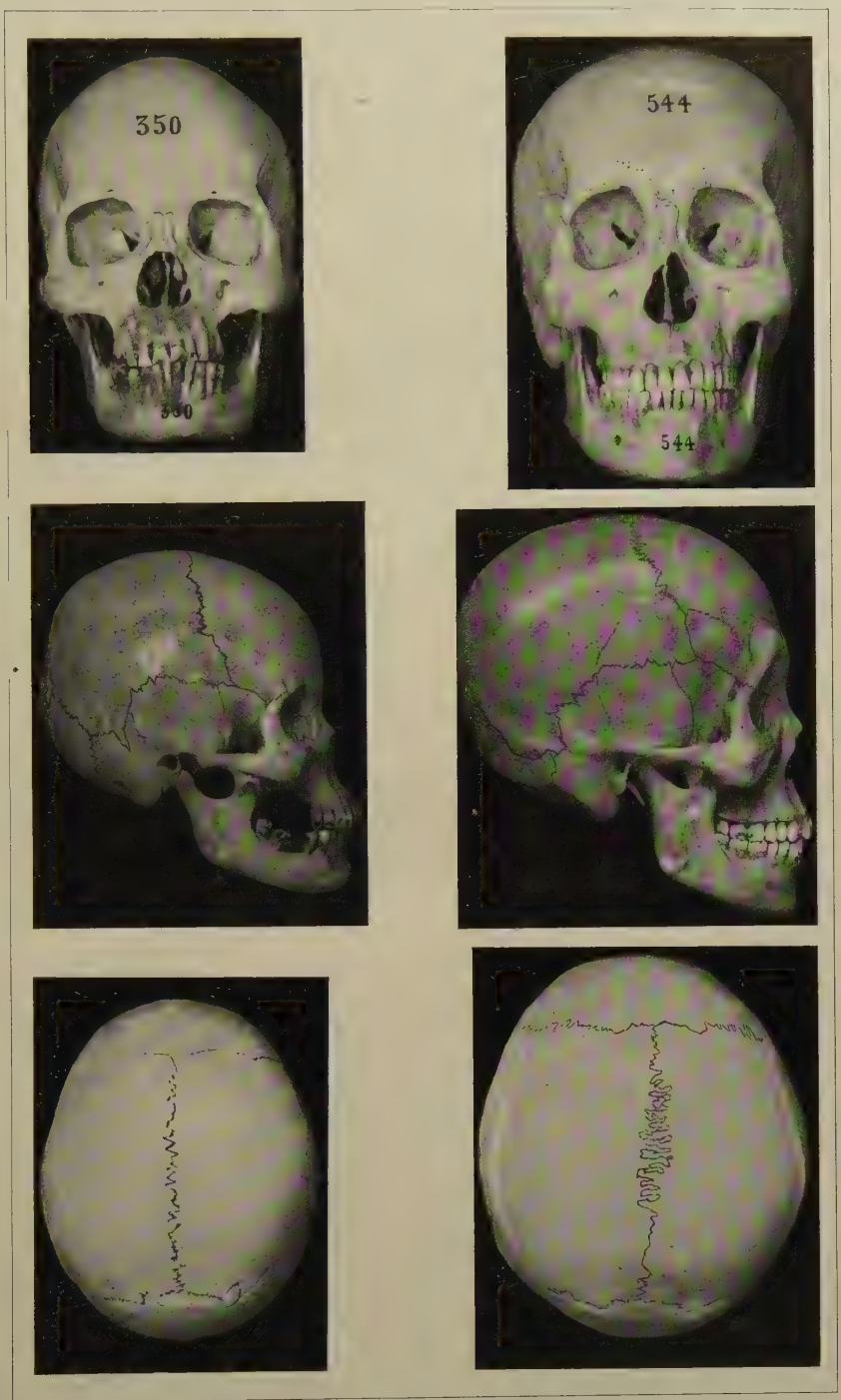

PLATE 2.

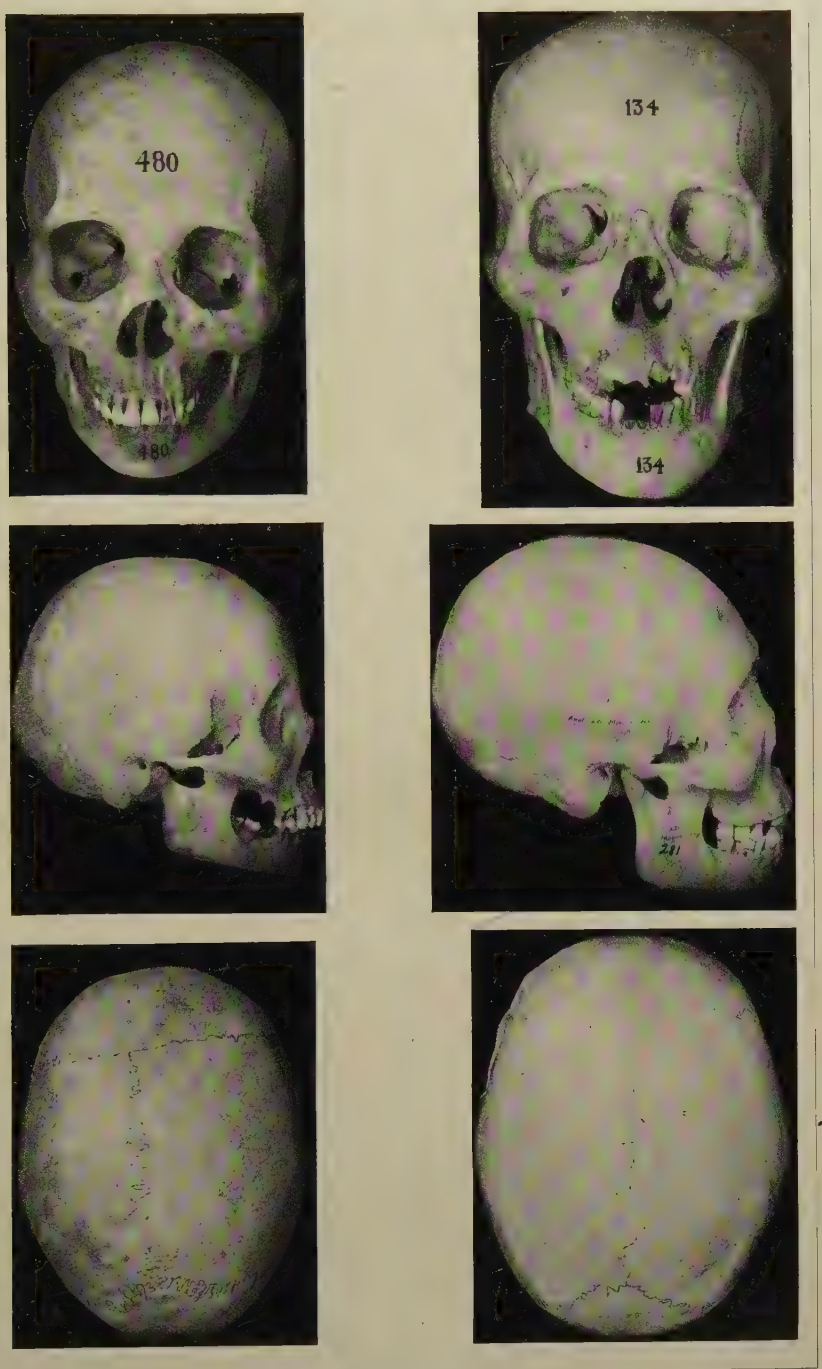

PLATE 3.

AN AMERICAN CYPRINODONT IN PHILIPPINE SALT PONDS

By Albert W. Herre

Of Stanford University, California

THREE PLATES

Mollienisia latipinna Le Sueur is a small cyprinodont fish native to the coastal region of the southern United States. It occurs from Virginia to northern Mexico and is very abundant in lowland streams and swamps. It often enters salt-water bays and inlets and is common in the shallow water about ports of the southern Atlantic and Gulf States. Le Sueur's type specimen came from New Orleans.

It was, therefore, a matter of great interest to discover that this little fish, belonging to a family confined to America, occurs in vast numbers in some of the salt-water fishponds and salt ponds around Manila Bay.

In the spring of 1927, while I was engaged in an exhaustive survey of the bangos ponds along the shore of Manila Bay, a small cyprinodont fish was discovered in certain localities. The fish was very well known to the caretakers of the ponds and was called "bubuntis" by them. Bubuntis is a Tagalog word meaning pregnant and is applied to this fish because of its large belly.

At first I supposed that bubuntis was new to science, but comparison with specimens of *Mollienisia latipinna* from Savannah, Georgia, showed their identity. Bubuntis is, therefore, a fish accidentally naturalized in a new locality halfway round the world from its natural habitat.

The most noticeable thing about the life of bubuntis in the Philippines is its remarkable toleration for salt. In the salt works it is rare in ponds filled with water fresh from the bay, with a salinity as low as 3.1 to 3.2 per cent, but is abundant in those with a salinity of 3.5 per cent. It continues to be abundant in salt ponds until the salinity increases to 6.3 per cent. When evaporation has brought the salinity up to 6.7 per cent bubuntis becomes very abundant, and continues to be so until the water of the ponds attains a salinity of 8.7 per cent.

This, however, seems to be near its limit of tolerance, for in ponds with a salinity of 9.4 per cent it has entirely disappeared. All other kinds of fish occurring in the salt ponds disappeared while bubuntis were still very numerous and lively.

In the Philippines bubuntis is thus far known only from the salt-water ponds maintained for the culture of bañgos (*Chanos chanos* Forskål), the salt-water creeks supplying them with fresh water from Manila Bay, and the ponds of salt works, situated only along the shore of Manila Bay, Luzon.

In 1905, Mr. Alvin Seale was commissioned by the Hawaiian Government to go to the United States and obtain fish feeding upon mosquito larvæ, these fish to be used in the antimalarial campaign then in progress in the Hawaiian Islands. At Seabrook, Texas, Mr. Seale obtained a quantity of *Gambusia affinis* and some specimens of *Mollienisia latipinna*. These he succeeded in transporting to Honolulu, where they were placed in ponds, streams, and irrigation ditches. Here they found conditions just as congenial as in their native habitat. *Gambusia* proved to be wonderfully efficacious in devouring mosquito larvæ, but *Mollienisia* was of no practical utility for this purpose.

In 1913 while returning to Manila from the United States, Mr. Seale took twenty-four specimens of *Gambusia affinis* from Honolulu to the Philippines. Here they reproduced as rapidly and were just as valuable in destroying mosquito larvæ as in the Hawaiian Islands.

In 1914, the Director of the Bureau of Science sent to Honolulu for a shipment of *Gambusia*. A barrel of small fish was sent, but when the shipment arrived the fishes were found to be nearly all *Mollienisia*. These fish were placed in aquarium tanks, and Mr. Seale gave orders that they were not to be distributed with mosquito fish.

Apparently this order was disregarded after Mr. Seale left the Philippines in 1916. As a result *Mollienisia*, or bubuntis, now occurs in such abundance in some of the fishponds as to be a serious detriment to their success. This is especially true in the nursery ponds, since bubuntis there devour the food that bañgos fry feed upon, thus cutting down their food supply.

Bubuntis feed upon the algal complex that covers the bottom of nursery ponds. This layer, known as "cream of the mud" and called "lab-lab" by the Tagalogs, is composed of a mat of blue-green algæ with which are mingled diatoms, desmids, some fine filamentous green algæ, and quantities of protozoans and other microscopic animals. Bubuntis also eat the common green

filamentous algæ, the "frog spittle," or "lumut," of the fishponds, to a limited extent. The position of the mouth and the character of the teeth indicate that very small insects and insect larvæ must form a portion of their diet. I have examined microscopically the digestive tracts of many specimens and found them to contain large quantities of mud, mineral crystals, bits of filamentous algæ, unicellular algæ, and minute crustaceans or parts of them.

Bubuntis is one of the very few fishes not eaten by Filipinos, the reason being that the flesh is bitter.

POECILIDÆ

The statement made by most authors that in the Poecilidæ the dorsal fin begins in the caudal half of the body should be modified. In *Mollienisia* the dorsal fin begins in the middle or more often in the anterior half of the body, usually nearer the tip of the snout than the base of the caudal.

Genus MOLLIENISIA Le Sueur

Mollienisia LE SUEUR, Journ. Acad. Nat. Sci. Philadelphia 2 (1821) 3, pl. 3.

This genus is composed of small, viviparous, laterally compressed fishes, the females deeper bodied than the males; the depressed head flattened above, with a wide, blunt snout and very short mandible, its bones not united, the dentary movable; the vertical mouth protractile, the chin projecting; an outer row of very small, slender, pointed, curved teeth in each jaw; within and separated from the outer row by an interspace a double row of smaller teeth; upper and lower pharyngeals covered with minute, curved, pointed teeth; dorsal elevated in the male, of twelve or more rays, anal behind the dorsal and modified in the male to serve as an intromittent organ; ventral of six rays; caudal bluntly rounded, caudal peduncle deep; pectorals inserted on lower half of body; scales large, cycloid, covering the entire body except lips and preorbital; no lateral line; intestine much coiled, five or six times the total length, the anus posterior; gill opening broad, gill membranes free from isthmus; no pseudobranchiæ; branchiostegals 5 or 6.

Small fishes of fresh, brackish, and salt water, from Virginia to Central America.

MOLLIENISIA LATIPINNA Le Sueur.

Mollienisia latipinna LE SUEUR, Journ. Acad. Nat. Sci. Phila. 2 (1821) 3, pl. 3; GUNTHER, Cat. Fishes Brit. Mus. 6 (1866) 348; JORDAN

and EVERMANN, Fishes N. and M. Am. 1 (1896) 699; GARMAN, Mem. Mus. Comp. Zoöl. 19 (1895) 50, pl. 5, fig. 1; pl. 8, fig. 12; pl. 12.

Poecilia multilineata LE SUEUR, Journ. Acad. Nat. Sci. Phila. 2 (1821) 4, pl. 1.

Poecilia lineolata GIRARD, U. S. Mexican Boundary Surv., Ichthyology (1858) 70, pl. 35, figs. 9–11.

Limia poeciloides GIRARD, U. S. Mexican Boundary Surv., Ichthyology (1858) 70, pl. 38, figs. 8–14.

Limia matamorensis GIRARD, Proc. Acad. Sci. Phila. (1859) 116.

Tagalog name, bubuntis.

Dorsal II–10, or 11; anal III–6 in female; anal in male II+4+3, the middle rays much enlarged and modified to serve as an intromittent organ; scales 25 in longitudinal series, 9 or 10 in transverse series; predorsal scales 13 in female, 10 or 11 in male; branchiostegals 6 (Garman, and Jordan and Evermann give 5).

Head and body strongly compressed in male, depth 3 to 3.5 in length, not including caudal fin; the female has a large and often protuberant belly and the anterior half of the body somewhat thicker than in the male, depth 2.5 to 3 in length in female; caudal fin not included; dorsal outline arched, descending from dorsal to tip of snout in a straight or nearly straight line, head and nape broad and flat above, snout depressed and very broad; anterior dorsal and ventral profiles nearly equal, converging in straight lines at tip of chin; head 3.3 to 3.6 in length in female, 3.6 to 4 in male; interorbital 1.85 to 2.2, width of tip of snout 2.75 to 2.85 in head; eye 3.4 to 3.5 in head in female, 3.1 to 3.3 in male; snout equals or may slightly exceed eye in the female; in the male snout may equal eye but is usually shorter, 3.3 to 4 in head; mouth vertical or nearly so, upper jaw with about forty, minute, laterally inclined teeth in a curved row, which is indented at the middle; at a little distance behind is a band of two rows of very minute teeth, divided into two parts by a central toothless portion, as shown in Plate 2; the lower jaw has a row of about sixty teeth like those above, arranged in two curves with a strongly marked incurved central loop; behind this and separated by a toothless space is a double row of very minute teeth as in the upper jaw, also divided into a right and a left half; three large pores on lower margin of preopercle and four on its posterior margin; scales on top of head larger than those elsewhere; origin of dorsal above pectoral, far in advance of anal and above or in front of ventrals; origin of dorsal sometimes at posterior end of first third of body in males and always well forward in the anterior half; in females it

never begins so far forward and sometimes is midway between tip of snout and base of dorsal; in females the longest dorsal ray is 2 or 2.2 times in head, the posterior rays little if any elongated; in males the dorsal is much more developed, first dorsal spine 2 in head, the rays longer, posterior rays successively elongated, the next to the last one longest, equal to head or to depth; least depth of caudal peduncle about 1.2 or 1.4 times in head; caudal broadly rounded, equal or nearly equal to head; pectoral a little shorter than caudal; in females origin of anal beneath posterior part of dorsal, opposite eleventh scale in the longitudinal series, and far behind pectoral; in males its origin is beneath anterior part of dorsal, beneath posterior half of pectoral and opposite eighth scale in the longitudinal series; origin of anal seven scales behind that of ventrals in females, four scales in males; anal shorter in females than in males, its base tumid and elevated in males, the longest modified ray in males 0.7 or 0.8 of length of head; six ventral rays, but apparently only five in males, second and third rays fused and elongate; the elongate modified ventral ray in males extends over half of anal; about 1.4 times in head; ventral shorter in females, more than twice in head; an enlarged scale covers the angle between the two ventrals; gill rakers 24 on outer arch, 28 on inner arch; peritoneum shining black.

Color silvery to brownish, dusky above, belly yellowish or whitish; some specimens have more or less yellow below dorsal and behind eyes, and also on caudal peduncle; opercle bright silver in females, dark in males; each scale with a black or yellow spot, except on breast and belly, these forming seven to nine longitudinal rows; males with eight vertical bluish dusky bars, the posterior ones often disappearing; rarely they are present on females; dorsal with three or four longitudinal or diagonal rows of circular black spots, and in males with an orange margin; caudal gray in females; caudal orange in males, with a broad black margin and several partial crossbars of blackish spots; other fins colorless or like body.

Here described from a study of 774 specimens, 13 to 48 millimeters in length, obtained from fishponds and salt ponds near Obando, Bulacan Province, Luzon, where this fish is exceedingly abundant. I also have 168 specimens from a salt-water creek at Malolos and a few from fishponds near Malabon. In the catching ponds of bañgos fishpond systems in the above-mentioned localities I have seen many tens of thousands of bubuntis in a single great shoal. From such a mass at least five thousand may

be scooped up in one stroke of a large long-handled dipnet. It is easy to see how harmful these defenseless little fishes really are to the financial well being of the fishpond owners, and how difficult it is for the young bañgos fry to get their living under the fierce competition with swarms of full-grown bubuntis.

Specimens 30 millimeters long are sexually mature. Males rarely reach a length of more than 35 millimeters, and never grow to the size attained ordinarily by females. Collections made during the latter part of May contained many females full of eggs, which had an average diameter of 2 millimeters. The number of eggs is variable, even in fishes of the same size. A specimen 42 millimeters long contained 75 eggs; one 46 millimeters long had 64 eggs, and another 44 millimeters in length had only 55 eggs. A few specimens had embryos nearly ready for birth; a female 32 millimeters long contained 24 embryos almost mature. The coiled embryos are about 3 millimeters in diameter when nearly ready for delivery. The anal opening in females is separated by a comparatively wide space from the opening of the oviduct, which is at the base of the first anal spine.

ILLUSTRATIONS

[Drawings by Pablo Bravo.]

PLATE 1. MOLLIENISIA LATIPINNA LE SUEUR; × 4

PLATE 2. MOLLIENISIA LATIPINNA LE SUEUR

FIG. 1. Teeth of upper jaw.
2. Teeth of lower jaw.
3. Upper pharyngeal teeth.
4. Lower pharyngeal teeth.
5. Ventrals of male.
6. Anal of male, enlarged.
7. Anal, greatly enlarged.
8. Male, dorsal aspect of head.

PLATE 3. MOLLIENISIA LATIPINNA LE SUEUR

FIG. 1. Adult female, lateral view; × 1.5.
2. Adult female, with eggs; × 1.5.
3. Adult female, with embryos ready to deliver.
4. Female, dorsal aspect of head.
5. Embryos.

PLATE 1. MOLLIENISIA LATIPINNA LE SUEUR.

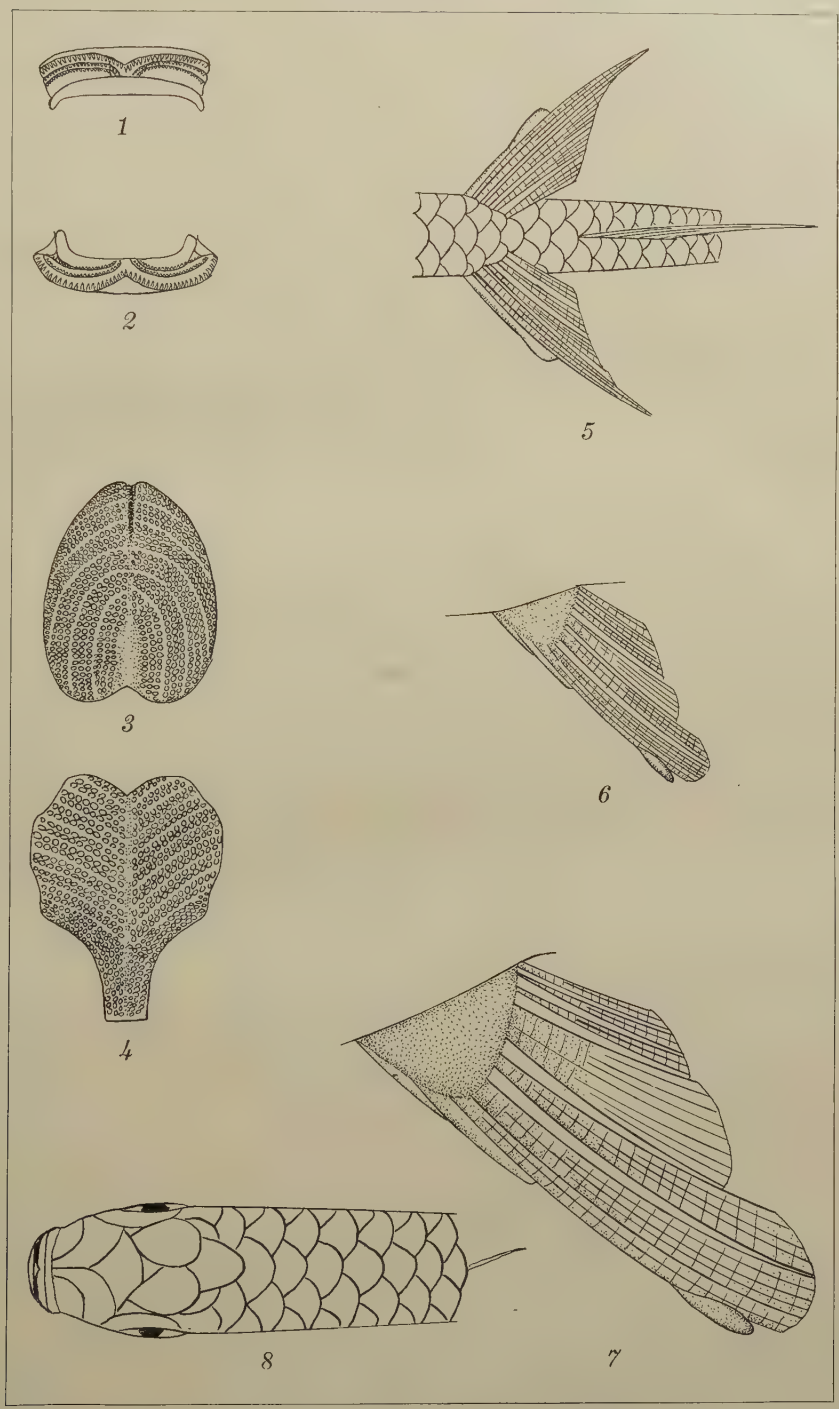

PLATE 2. MOLLIENISIA LATIPINNA LE SUEUR.

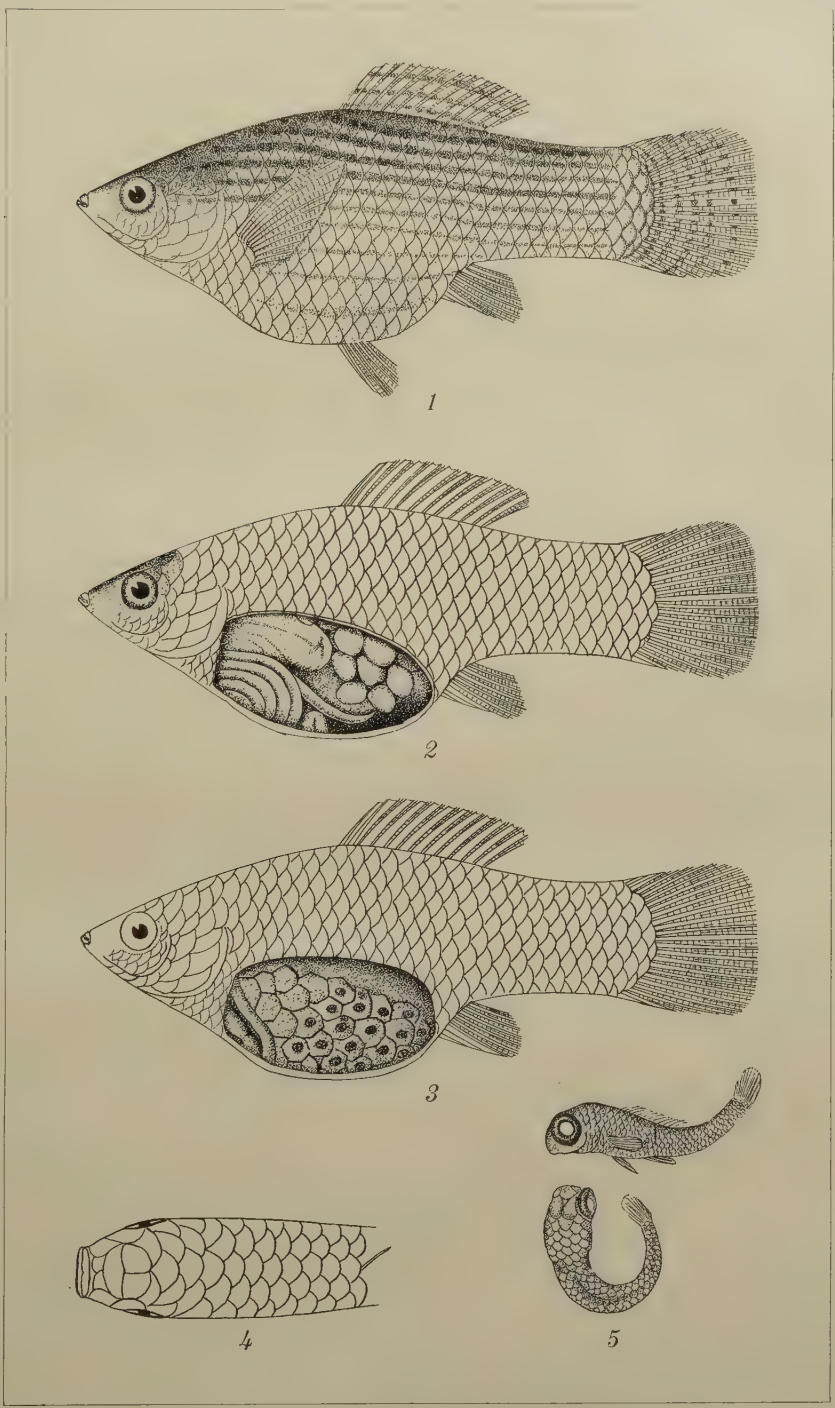

PLATE 3. MOLLIENISIA LATIPINNA LE SUEUR.

NEW OR INTERESTING FERNS

By E. B. COPELAND

Of Chico, California

FIVE PLATES

CYATHEA GIBBSIAE Copeland, nom. nov.

Polybotrya arfakensis GEPP, in Gibbs, Dutch NW. New Guinea (1917) 71, pl. 4.

This species was born to science, as just indicated, in 1917, and enjoyed a hectic babyhood. In the following year, van Alderwerelt [1] based on it a new genus, *Thysanobotrya*. After hardly more than another year, Brause [2] reduced it, generically and specifically, to *Cyathea biformis* Copeland, Philip. Journ. Sci. § C 6 (1911) 364, *Alsophila biformis* Rosenstock, Fedde's Repert. 9 (1911) 423.

Like Brause, I have not seen it, but van Alderwerelt's figures make its nature perfectly plain; I do not believe that it is specifically identical with *C. biformis*. Of this, I have the excellent specimen collected by Mr. King for study; the one described by Rosentock is evidently a much less perfect duplicate. There is no note to show that it was scandent, and I did not so suspect, until Brause described a series of scandent species clearly nearly related to it. The true trunk, near the upper end, is hardly 15 millimeters in diameter, this being approximately doubled by the outside layer of roots and scales, and still further increased at the top by the appressed bases of the stipes. It is somewhat flattened on one side, strengthening the probability that it grew against a tree trunk. The stipes and rachises are black rather than dark purple, though Rosentock and Gepp agree on the latter term. The stipes are appressed to the trunk for perhaps 10 centimeters. From the point where they begin to spread, it is only a few centimeters to the lowest pinnæ, which are less than 10 centimeters long, and sterile. The stipe and a considerable part of the main rachis are clothed on the upper side with persistent, narrow, chestnut scales, 8 to 10 millimeters long. The sterile pinnules reach a length of fully

[1] Bull. Jard. Bot. Buit. II No. 28 (1918) 66, pl. 10.

[2] Hedwigia 61 (1920) 401.

10 centimeters, and bear on the under surface sparse, but rather persistent, small, lanceolate-ovate scales. On my specimen, at least, the dimorphism is of the pinnules, not of the pinnæ. Because Gepp described his plant as different in almost all of the features just noted, I think that the two must be specifically different; but they are surely very closely related. Since he used the same specific name for this plant and also in *Cyathea* and in *Alsophila,* a new one becomes necessary; I name it after Miss Gibbs, the collector, in appreciation of her several important contributions to our knowledge of the mountain vegetation of the Island World.

While the treatment received by *Thysanobotrya* illustrates the natural consequence of generic description while the "true systematical place is uncertain," by those who esteem discussions of phylogeny too trivial to be fit for publication, the fact remains that this is the generic name this plant, and the considerable number of its recognized near relatives, may bear. The affinity of this group of exindusiate species to the group that includes the type of *Alsophila* is decidedly remote. Those of us who are guided by affinity, more than by the chance possession of some arbitrarily selected common characteristic, in the recognition of genera, may place this species in *Cyathea,* or in *Thysanobotrya,* but not possibly in *Alsophila.* In this particular case, there happens to be another alternative. Blume long since proposed a distinctive name for the group of exindusiate species to which this one is directly related—*Gymnosphaera,* Enumeratio (1828) 242. Within *Cyathea,* this is one of the most clearly marked groups of species.

CYATHEA LEUCOSTEGIA Copeland, sp. nov.

Adsunt pinnæ mediales; rhachi frondis 15 mm crassa, spinulosa, sub tegmine furfuraceo fusco atropurpurea; pinnis 40 cm longis, ca. 18 cm latis, abrupte acuminatis, stipitibus earum ca. 2 cm longis, rhachibus superne bisulcatis fulvo-strigosis, inferne asperis atropurpureis decidue furfuraceis; pinnulis sessilibus, infimis 5 cm longis, medialibus fere 10 cm longis, 18–20 mm latis, proximis, acuminatis, rhachillis superne strigosis, inferne deorsum paleis ovatis 1 mm longis albo-stramineis castaneo-ciliatis et apiculatis, et aliis minutis fulvis irregularibus vestiutis, sursum glabrescentibus; pinnulis II ca. 7-paribus stipitulatis, sequentibus adnatis, solummodo sterilibus minoribus paucis subapicalibus confluentibus, liberis fere 10 mm longis, 2.5–3 mm latis, obtusis, rectis vel subfalcatis, sursum serratis, deorsum crenulatis, basibus acroscopice hastulato-truncatis basiscopice

truncato-rotundatis, subcoriaceis, superne atroviridibus glabris, inferne pallidus viridibus costis deorsum paleis parvis ovatis stramineis ornatis; soris magnis, medialibus, indusiis albidis etiam fissis persistentibus.

CAMIGUIN DE MINDANAO, *Bur. Sci. 14878 Ramos,* 1912.

CYATHEA LEYTENSIS Copeland, sp. nov.

Affinis et similis speciei praecedenti, qua differt: Pinnis subsessilibus, 60 cm longis, 20 cm latis; squamis rhachillarum brevioribus, minus conspicuis, albo-ciliatis; pinnulis II liberis sessilibus utroque latere hastato-truncatis, ubique crenatis vel crenato-lobatis et vix ad apices serratis; indusiis fulvo-stramineis.

LEYTE, Dagami, *Bur. Sci. 15268 Ramos,* 1912.

This and the preceding species are related to each other more nearly than to any species previously described. The conspicuously crenate secondary pinnules of *C. leytensis* suggest *C. fructuosa,* which is found in Leyte as well as in Negros; but that species, aside from less-conspicuous distinctions, has notably darker indusia and paleæ; also, its indusia tend, in rupturing, to leave large, regular cups, while the thinner indusia of these species crumple irregularly.

CYATHEA DEUTEROBROOKSII Copeland, nom. nov.

Cyathea brooksii COPELAND, Philip. Journ. Sci. § C 6 (1911) 135, pl. 16, non *C. brooksii* MAXON, 1909.

Alsophila sarawakensis C. CHRISTENSEN, Index Suppl. (1913) 5, non *Cyathea sarawakensis* HOOKER, 1865.

CYATHEA MELANOPHLÆBIA Copeland, sp. nov.

Trunco, teste Ramos, 2 m alto, 10 cm crasso; stipite sursum 15 mm crasso, spinis validis acutis 1–2 mm longis munito, aliter ignoto; rhachi castanea; pinnis infimis ca. 15 cm longis, stipitatis, bipinnatis, non deflexis; medialibus 50 cm longis, 16–20 cm latis, subsessilibus, rhachibus castaneis, solummodo deorsum minute asperulis, decidue castaneo-furfuraceis mox glabrescentibus; pinnulis usque ad 10 cm longis et 25 mm latis, subsessilibus, caudatis, rhachillis primo paleis et squamulis sparse vestitis, mox glabris; pinnulis II infimis sessilibus, sequentibus adnatis, plerisque ala angusta confluentibus, lineari-oblongis, ca. 13 mm longis, 3–4 mm latis, inter se 2 mm distantibus, obtusis, ubi soriferis ibidem bullato-crenatis, ad apices serratis, coriaceis, costis inter soros sparse paleatis, aliter glabris, superne fere nigris, inferne olivaceis, venulis inferne conspicue nigris; soris utroque latere costæ usque 8, paginam fere complentibus, indusiis castaneis, nitidis, sat persistentibus.

LUZON, Nueva Vizcaya Province, Mount Alzapan, altitude 1,500 m. s. m., *Bur. Sci. 45639 Ramos and Edaño.*

This has some resemblance to *C. tripinnata* and *C. callosa,* but is not clearly related to either. The somewhat bullate shallow lobes of the fertile pinnules suggest also the Javan *C. oinops.*

CYATHEA CAMPBELLII Copeland, sp. nov.

Trunco et stipite ignotis; rhachi valida, castanea, minute asperula, glabrescente, aerophoro conspicuo ad basin pinnae quaeque ornata; pinnis majoribus 30–40 cm longis, 10–13 cm latis, sessilibus, abrupte ad apicem pinnatam contractis, rhachibus deorsum inferne glabrescentibus, primo et alibi dense fulvo-furfuraceis et sparse paleatis, superne ubique dense strigosis; pinnulis contiguis vel imbricatis, sessilibus, vix caudatis, rhachillis inferne deorsum paleis (1) albidis lanceolatis 2 mm longis deciduis, (2) minoribus ovatis fuscis sub albidis adspersis, et (3) squamulis, minutis obscuris amorphis ornatis; pinulis [11] infimis paucis sessilibus, sequentibus adnatis, plerisque ala angusta confluentibus, usque ad 1 cm longis sed plerumque brevioribus, vix 2 mm latis, falcatis, apice rotundatis, integris, coriaceis, superne atroviridibus, inferne fusco-olivaceis; costis deorsum inferne paleis atris parvis dense obtecto, deinde squamulis minutis fulvis vestito, pinnulis alibi glabris; venulis inconspicuis, aut apud costas furcatis aut simplicibus; soris costalibus, indusio incerto.

LUZON, Benguet Subprovince, Mount Bulusan, altitude ca. 2,500 m. s. m., *Copeland s. n.,* 1913.

There are only a few sori on my specimens; they were collected in a storm, and the black paleæ on the costæ look to the naked eye like copious sori. In its display of very diverse paleæ, this is one of the most remarkable ferns of the genus, especially when it is noted that the main axes are glabrescent. *Cyathea fuliginosa,* of the same region, has also diverse paleæ, but none so white or so black as are found on this species. It is named for Prof. D. H. Campbell, eminent in the study of the morphology of ferns, who was my companion on the trip when it was found.

CYATHEA URDANETENSIS Copeland, sp. nov.

Trunco, teste Elmer, 3 m alto, 12 cm crasso; fronde 3 m longa, tripinnatifida; rhachi 15 mm crassa, spinosa, fulvo-castanea et nigro-maculata, paleis stamineis parvis lanceolatis mox deciduis ornata; pinna mediale longe (6 cm) stipitulata, 40 cm longa, 20–25 cm lata, rhachi deorsum aspera, inferne furfuracea, superne canaliculata et ibidem minute fusco-strigosa; pinnulis approximatis, subimbricatis, pedicellatis, medialibus 10–13 cm lon-

gis, 3–3.5 cm latis, horizontaliter patentibus, basiscopice cordatis, sensim acuminatis non caudatis, ¾ ad costam pinnatifidis, potius papyraceis quam coriaceis, costis inferne glabrescentibus, pinnulis infimis minoribus et deflexis; lobis contiguis, abrupte falcato-acutis, integris; indusio castaneo, tenue sed persistente.

MINDANAO, Agusan Province, Mount Duros, altitude 800 m. s. m., *Elmer 13473*, August, 1912.

Nearly related to *C. integra* J. Smith, of which I once regarded it as a form.[3] That species has always much laxer fronds, with smaller, much narrower, firmer, obtuse or subacute pinnules, standing well apart, instead of imbricate or in contact; their lobes likewise stand well apart, while in *C. urdanetensis* they are in contact for the most of their length. Typically, the lobes of *C. integra* are entire and blunt, but in these respects the species is variable. In my specimen of Robinson's Bureau of Science No. 6851, from Polillo, which is probably a cotype of *C. hypocrateriformis* v. A. v. Rosenburgh, some lobes are serrate and some are quite entire.

CYATHEA ARGUTA Copeland, sp. nov.

Trunco, teste Ramos, 2 m alto, 10 cm crasso; stipite 60 cm longo, atropurpureo, nitido, deorsum paleis crinitis linearibus albo-stramineis 8 cm longis vestito et fulvo-furfuraceo, ibidem spinis 5 mm longis tenuibus acutis atris deflexis armato, sursum rhachibusque glabrescentibus et spinis fere carentibus; fronde ovata, deorsum paullo angustata, tripinnatifida; stipitibus pinnarum medialium 3–4 cm longis; pinnis iisdem 55 cm longis, 25 cm latis, abrupte acuminatis; pinnulis remotis, usque ad 17 utroque latere, stipitulatis, subcordatis, acuminatis vel subcaudatis et apices versus argute grosse serratis, deorsum ¾ ad costam pinnatifidis, ca. 11 cm longis, 2 cm latis, infimis vix minoribus, costis inferne pilis fulvis et squamulis minutis amorphis sparse vestitis, superne minute fusco-strigosis; lobis contiguis, 8 mm latis, falcatis, obliquis, externe serratis, in dentem spiniformem terminantibus, tenuiter coriaceis, superne atroviridibus, inferne olivaceis; indusiis fuscis, persistentibus.

LUZON, Tayabas Province, Mount Alzapan, altitude 1,200 m. s. m., *Bur. Sci. 45727 Ramos and Edaño* (type); Casiguran, *Bur. Sci. 45314 Ramos and Edaño.*

This is a relative of *C. integra* J. Smith, from which it differs in the darker and more shining axes, smoother except at the base of the stipe, more ample foliage, thinner texture, darker upper

[3] Leaflets of Philip. Bot. 5 (1913) 1680.

surface (blackish rather than lurid), acuminate pinnules very conspicuously toothed near the apex, and broader but less separate lobes, serrate with spinelike points. *Cyathea integra* is one of the few tree ferns found throughout the length of the Philippines. Recognizing it as variable, I have still imperfect specimens of what I regard as several more related species.

CYATHEA SESSILIPINNULA Copeland, sp. nov.

Trunco ignoto; stipite ultra 30 cm longo, deorsum spinuloso, sursum rhachibusque inermibus, fuscis, linea dorsale strigosa excepta glabris; fronde vix 1 m longa, ovata; pinnis infimis deflexis, 10 cm longis; medialibus 25–30 cm longis, vix 10 cm latis, fere sessilibus, acuminatis; pinnulis sessilibus, acumunatis, rectis vel falcatis, 5 cm longis, ca. 13 mm latis, ad vel ultra median laminam pinnatifidis, infimis vix minoribus, costis, inferne pilis fuscis minutis ornatis; lobis 3–4 mm latis, non contiguis, falcatis, integris, plerisque obtusis, subcoriaceis, glabris, superne atroviridibus, inferne olivaceis; indusiis fuscis, persistentibus.

BASILAN, *Bur. Sci. 16212 Reillo,* 1912.

One of the group of *C. integra,* as shown by color of axes and lamina, and the form and dissection of the frond; but clearly distinguished by smallness and slenderness, sessile pinnules and subsessile pinnæ. In color it is like *C. arguta.*

CYATHEA HETEROLOBA Copeland, sp. nov.

Trunco, teste Ramos, 3 m alto, 6 cm crasso; stipite breve, infra pinnas infimas remotas pinnatas 4 cm longas 15–20 cm longo, ad basin sub paleis linearibus castaneis nitidis occulto, sursum rhachique sordide furfuraceis, minute asperis, sordide fulvis; fronde 90 cm longa, 40 cm lata, utrinque angustata; pinnis sessilibus, medialibus maximis, 20–25 cm longis, 6–7 mm latis, acutis, rhachibus squamulis amorphis et praecipue sursum paleis subbullatis minutis albidis vestitis; pinnulis approximatis, sessilibus, obtusis, 3–3.5 cm longis, ca. 7 mm latis, majoribus ad rhachin pinnae pinnula ¤ una (rarius duo) libera orbiculare praeditis, deinde leviter lobatis et ultra mediam longitudinem solummodo leviter oblique crenulatis, papyraceis, superne obscuris, inferne pallide olivaceis, costis praecipue deorsum paleis minutis subbullatis albis ornatis; soris medialibus; indusio fusco, mox disrupto et praeter discum basalem irregularem evanescente.

LUZON, Nueva Vizcaya Province, Mount Alzapan, altitude 1,500 m. s. m., *Bur. Sci. 45633 Ramos and Edaño.*

Probably a relative of *C. philippinensis* and *C. robinsonii,* but one of the most distinct species in the genus. The small

pinnules, almost entire in their distal halves but cut to the costa at their bases, are quite unique.

CYATHEA PSEUDALBIZZIA Copeland, sp. nov.

Trunco, teste Ramos, 1 m alto, 4 cm crasso; stipite 30 cm longo, ad basin paleis anguste linearibus ferrugineis sub lente cinereis minute ciliatis dense vestito, sursum rhachique fuscis, densissime minute tuberculatis, fusco-furfuraceis, 6 mm crassis; fronde 60 cm longa, late ovata; pinna infima 15 cm longa; mediale 30 cm longa, ca. 12 cm lata, copiose bipinnata, stipite 2–3 cm longo, pinnulis hujus infimis longe (5–10 mm) stipitulatis, medialibus subsessilibus, usque ad 7 cm longis, 12 mm latis, sensim acuminatis, costis inferne dense paleaceis, paleis castaneis difformibus; pinnulis II remotis, infimis brevissime pedicellatis orbiculari-oblongis rotundatis, superioribus adnatis obliquis plerisque acutis, integris, ad costas et venulas inferne piliferis, rigide coriaceis, superne nigris, inferne fusco-viridibus.

LUZON, Isabela Province, Mount Moises, altitude 1,150 m. s. m., *Bur. Sci. 47350 Ramos and Edaño.*

Another member of the group of *C. philippinensis,* nearer to *C. robinsonii* than to any other species previously known.

DRYOPTERIS WEBERI Copeland, nom. nov.

Dryopteris dichrotricha COPELAND, Philip. Journ. Sci. § C 7 (1912) 54, non COPELAND, Philip. Journ. Sci. § C 6 (1911) 74.

The two ferns to which I gave the same name, only a year apart, are not at all alike and were not thought to be. In spite of quite illustrious precedents for this carelessness, it seems to me inexcusable.

DRYOPTERIS BAKERI (Harrington) Copeland.

Dryopteris bakeri (Harrington) COPELAND, Philip. Journ. Sci. § C 2 (1907) 405.

Nephrodium bakeri HARRINGTON, Journ. Linn. Soc. Bot. 16 (1877) 29.

To this species, hitherto known from Panay and Negros, I am now referring collections from northern Luzon, *McLean and Catalan 95,* from Claveria, Cagayan Province. This is in part larger than the species as known before, with fronds up to 20 centimeters long and 3 centimeters wide. The basal pinnæ of smaller fronds are as originally described, not larger than the lobes which follow them; but on the larger fronds these pinnæ are up to 3 centimeters long, obovate with broadly truncate base, and shallowly lobed. There may be a second pair of free pinnæ, but these are not enlarged or but slightly so. Except that the veins are simple, and supplementary areolæ are therefore wanting, this would be *Haplodictyum majus.*

DRYOPTERIS CESATIANA C. Christensen.

Dryopteris oblanceolata COPELAND, Philip. Journ. Sci. § C 9 (1914) 3.

King 477, from the mountains behind Wedan, Papua, is this species, but is much larger than the specimen originally described. The tips are missing from the largest fronds, but these have stipes up to 10 centimeters long; then a series of five or six pairs of remote, dwarfed, adnate pinnæ, strung along the rachis for 15 centimeters; and the linear-oblanceolate body of the frond is probably considerably more than 40 centimeters long. The fructification covers the lamina completely in places, but more generally is typically meniscioid. The known range is eastward to Fiji.

CYRTOMIUM INTEGRIPINNUM (Hayata) Copeland, comb. nov.

Polystichum integrifolium HAYATA, Icones Fl. Form. 4 (1914) 196, fig. 133.

Faurie 550, from Mount Arisan (the type locality), altitude 2,500 meters, "secus aquas in humidis sylvarum," conforms well to Hayata's description and figures. It has a moderately stout, and only moderately scaly suberect caudex. The lower part of the stipe is almost covered by the persistent bases of otherwise deciduous paleæ.

CYRTOMIUM NEPHROLEPIOIDES (Christ) Copeland, comb. nov.

Polystichum nephrolepioides CHRIST, Bull. Geog. Bot. Mans. (1902) 258.

The transfer to *Cyrtomium* is made on the evidence of Cavelerie's No. 1216.

TECTARIA DOLICHOSORA Copeland, sp. nov.

T. rhizomate erecto, brevi, valido, radicibus multis crassis, basibus stipitum, et ad apicem paleis castaneis linearibus obtecto; stipitibus caespitosis, hic illuc paleis paucis castaneis ornatis, 40–60 cm altis, costisque ebeneis nitidis; fronde cordato-deltoidea, 30–35 cm alta, 20–30 cm lata, profundissime tripartita, segmento mediale utroque latere et segmentis basalibus basiscopice pinnatifidis, subcoriacea, glabra, olivacea; venulis anastomosantibus cum liberis simplicibus vel hamatis inclusis; soris omnibus secus venulas elongatis, 2–5 mm longis, 1.5 mm latis, plerisque rectis; indusiis coriaceis, persistentibus, marginibus ubique liberis.

LUZON, Cagayan Province, Claveria, "steep leeward side of summit of West Mountain," *McLean and Catalan 160,* December, 1919.

The very remarkable sori distinguish this species sharply from all others known in its genus. Elongate sori are not so rare; but the usual tendency, in these as in other ferns, is for the indusium to disappear when the sorus exceeds the usual limits of the group. Except for the sorus, this resembles *T. melanocaulon.*

Bur. Sci. 13828 Ramos, collected in Cagayan in 1912, and long left without a name, seems to be an immature form of this. The frond is much less divided and not quite so large, and the sori are only slightly elongated.

TECTARIA DICTYOSORA Copeland, sp. nov.

Rhizomate ignoto; stipite 40 cm alto, rufo-castaneo, nudo sulcato, rigido, gracile; fronde late ovata, pauci-pinnata, herbacea, superne viride, glabra, inferne olivacea; pinnis unipariibus oppositis, ca. 12 cm longis, 3 cm latis, utrinque angustatis, subcaudatis, margine integris vel undulatis, basi adnatis, et breviter anguste decurrentibus, costa etiam distincte decurrente, glabra; venis inferne minute hirtis; parte mediale frondis trifida, segmentis lateralibus pinis similibus, decurrentibus sed ala insertionem pinnarum non attingente, segmento mediale majore; venulis irregulariter anastomosantibus cum liberis inclusis paucis; soris exindusiatis ad venulas nullibi interruptis, denique interdum parenchyma tamen occupantibus, pilis capitulatis (paraphysibus) inter sporangia dense inmixtis, capitulis eorum plerisque trilobatis lobo quoque hyalino unicellulare; sporangiis nudis.

Canton, collected under Levine's direction in 1917, herbarium of Canton Christian College No. 1949, type in United States National Herbarium.

This was distributed as *Dictyocline griffithii,* with which it shares its most conspicuous feature, the reticulate "sori." The immediate real affinity, however, is not to that fern, but to the exindusiate members of the group of *Tectaria vasta.* With these it shares color, texture, the conspicuous decurrent costæ of pinnæ and segments, and the very characteristic paraphyses. *Dictyocline* also is presumably a tectarid fern, but I do not yet know its source more precisely than that. It has no near affinity to the group of "Vastae."

TECTARIA ASPIDIOIDES (Presl) Copeland, comb. nov.

Heterogonium aspidioides PRESL, Epim. Bot. (1894) 143.
Digrammaria ambigua PRESL, Tentamen (1836) 117.
Tectaria ambigua COPELAND, Philip. Journ. Sci. § C 2 (1908) 415.
For other synonymy see Christensen's Index.

The name *ambigua* is invalid because it did not originate with Presl, as from the citations it seems to do, but is taken from *Asplenium ambiguum* Swartz, which is *Athyrium esculentum.*

TECTARIA BUCKHOLZII (Kuhn) Copeland, comb. nov.

Aspidium buckholzii KUHN, in von Decken, Reis. Bot. (1879) 47.

This Kamerun fern has the anastomosis of the veins conspicuously like that of *T. aspidioides.* Otherwise, they do not seem at all nearly related.

TECTARIDIUM MACLEANII Copeland.

Tectaridium macleanii COPELAND, Philip. Journ. Sci. **30** (1926) 329.

This fern has been collected at Claveria, Cagayan Province, *McLean and Catalan 84,* December, 1919.

ATHYRIUH ALTUM Copeland, sp. nov.

Athyrium A. Merrilli affine rhizomate erecto; stipitibus caespitosis, 6–10 cm longis, fusco-nigris, paleis angustis atro-castaneis vel atris patentibus 2 mm longis dense vestitis; fronde 30 cm alta, lineare, utrinque gradatim angustata, acuminata, pinnatifida, coriacea, superne obscure viride inferne olivacea, costa superne sparse inferne densius paleacea; segmentis medialibus ca. 2 cm longis (a costa ad apicem), 5 mm latis, rotundatis, fere rectis, integris, sinubus 2–3 mm latis separatis, ala 3–4 mm lata connexis, deorsum sensim abbreviatis, infimis quam longis duplo latioribus, non liberis; soris a costula ad marginem protensis; indusio brunneo.

MINDANAO, Agusan Province, Mount Urdaneta, altitude 1,800 m. s. m., *Elmer 14081,* 1912 (type); formerly determined and distributed as *A. merrilli.* LUZON, Tayabas Province, Umiray, *Loher 13618,* 1915.

This differs from *A. merrilli,* which we now have from Basilan (*Bur. Sci., 16187 Reillo*) as well as from Mindoro, in the longer stipes, much longer and narrower frond, with narrower segments, remote instead of contiguous or imbricate, and decidedly firmer texture. Some fronds of Loher's collection are a little broader than here described, and one has a single elongate basal segment, which seems to be a mere freak.

Very conspicuous characters always tend to distract attention from those less salient. This is best shown by the bunching of all the species of isolated genera, such as *Angiopteris.* Differences between *Davallodes* species, so clear that in other groups genera have been distinguished by them, have similarly been refused recognition as of specific value, by those blinded by the common characters of the genus. The group of *Athyrium*

porphyrorachis is likewise so clear-cut as a whole that there is the same natural tendency to regard its members as all one variable species. Once, however, the differences within such a group are recognized, there is no sound reason for denying them the importance granted them in other groups.

ATHYRIUM LONGISSIMUM Copeland, sp. nov.

Athyrium A. porphyrachi affine foliis pinnatis; caudice erecto; stipitibus caespitosis, validis, 5–10 cm longis rhachibusque nigris, paleis patentibus angustis 5 mm longis atris dense vestito: fronde 50 cm alta, lineare, utrinque attenuata; pinnis utroque latere 30–40, medialibus adnato-sessilibus 2.5–3 cm longis, e basi 1 cm lata sensim ad apicem acutam (rarius obtusam) angustatis, basi basiscopice excisis, acroscopice subauriculatis saepe supra rhachim imbricatis, herbaceis, superne atroviridibus, inferne pallidioribus, costulis inferne sparse et interdum venulis sparsissime paleis minutis vestitis; pinnis inferioribus sensim abbreviatis et rotundatis, infimis paullulum remotis, superioribus praecipue acroscopice plus adnatis; venis plerisque furcatis, inter se remotis; indusio nigro.

LEYTE, Dagami, *Bur. Sci. 15269 Ramos,* 1912.

Though clearly related to *A. porphyrorachis, A. merrilli,* and *A. altum,* all with pinnatifid fronds, this is a remarkably distinct species. Except for its conspicuous paleæ, it bears a striking resemblance to *Asplenium longissimum* Blume.

ATHYRIUM BANAHAOENSE Copeland, sp. nov.

Rhizomate erecto vel adscendente, paleis castaneis, 3–4 mm longis, lanceolatis valde attenuatis vestito; stipitibus caespitosis, longioribus ca. 6 cm longis, deorsum nigris, paleis angustis patentibus curvatis vel contortis marginibus sparse spinosis vestitis; rhachi stramineo-viride vel nigrescente, glabrescente, superne utroque latere sub lente angustissime alata; fronde 15–28 cm alta, lineari-lanceolata, utrinque attenuata, infra apicem serratam parte frondis pinnatifida 3–4 cm longa, alibi pinnata; pinnis multis, stipitulatis pecidello cum rhachi coalato 1 mm longo, medialibus maximis vix 2 cm longis, absque auricula 6 mm latis, obtusis, serratis vel inciso-serratis, basi basiscopice cuneatis, acroscopice truncato-auriculatis auricula magna rotundata, firmiter papyraceis, inferne pallido-viridibus, superne obscuris, costa inferne paleis paucis filiformibus caducis praedita, aliter glabris; venis in auriculis pinnatis, alibi plerisque furcatis; soris plerisque diplazioideis; indusiis brunneis.

LUZON, Mount Cristobal, altitude 800 m. s. m., *Copeland s. n.,* May, 1908, type.

Elmer 7965, Mount Banahao, is partly typical, but some plants have browner paleæ and more acute pinnæ. *Elmer 7964,* Mount Banahao, is a dwarf form. *Bur. Sci. 13373 Ramos* has the sori more crowded and the wing of the rachis hardly visible. Because of its reduced but not more deeply cut lower pinnæ, *Boyce 13,* from Tarlac, is referable here rather than to *A. williamsii;* but it has larger and more deeply cut pinnæ than any of our specimens from the Banahao region.[4] The larger fern there referred to is *A. elmeri,* an exindusiate species, hitherto reported only from Mount Canlaon and the Horn of Negros.

San Cristobal, or Cristobal, is the western of three cones making up the Banahao mountain mass. Elmer's specimens come from the eastern one, the Lucban cone. On all three, the fern named for the mountain is common in moist woods at middle elevations. I have tried many times to see that it merges into any other species, but found no such evidence. The reduced lower pinnæ and more-entire pinnæ distinguish it clearly from its immediate relatives. *Athyrium acrotis* (Christ) must be very similar in general appearance, but is described as light green; this might signify little in most groups of ferns, but among these little Philippine athyriums it is always associated with peculiarities of texture and paleæ, and marks the group of *A. grammitoides.*

ATHYRIUM RAMOSII Copeland, sp. nov.

Rhizomate erecto, gracile, paleis minutis nigris vestito; stipitibus caesuitosis, plerisque ca. 12 cm longis, rhachibusque paleis parvis angustis castaneis aspero-marginatis distantibus haud dense vestitis; fronde 15–20 cm alta, lanceolata, apice acuminata pinnatifida, bipinnata, obscure viride inferne paullo pallidiore, tenue sed (sicca) firmiter papyracea, glabra; pinnis brevi-pedicellatis, erecto-patentibus, infimis aequilongis vel paullo quam sequentes majoribus 2 cm longis, 1–1.5 cm latis, obtusis, ovatis, pinnatis; pinnulis infimis pinnarum inferiorum rotundo-oblongis vel variiformibus, semper apice rotundatis grosse et argute pauci-dentatis, basi cuneatis, interdum cum pinnula II una cuneata acroscopica libera; pinnulis aliis obovatis cuneatis, apice rotundatis et ibidem inciso-dentatis, ca. 5 mm longis, 2–4 mm latis; pinnis apicem versus frondis gradatim decrescentibus, angustioribus et simplicioribus; venis paucis, quaque in dentem protracta, dentibus lateralibus saepius incurvatis, apicalibus rec-

[4] See Philip. Journ. Sci. § C 3 (1908) 297, for comment on this and on the plants now named *A. banahaoense.*

tis; soris longis, rarius bilateralibus; indusio brunneo, persistente.

CAMIGUIN DE MINDANAO, *Bur. Sci. 14852 Ramos.*

After many years of observation and copious collection in this group, I am again, rather than still, of the opinion held twenty years ago, that a rather fine discrimination of its species is expedient. If the contrary policy were adopted, this might be construed as a form of *A. geophilum,* a species of the same region, which is typically smaller, more lax in habit but essentially less dissected and less scaly. It is less immediately related to *A. bolsteri,* which, among other differences, has the upper part of the frond cut to a winged rachis for a long distance, while this part of the frond is very short in *A. ramosii.*

This collection is cited by Hieronymus under *Asplenium squamiligerum* (Rosenstock) Hieronymus, Hedwigia 61 (1919) 5, nomen nudum. The name does not have to be conserved, and would invite confusion with *A. squamigerum;* but my chief reason for rejecting it is that I doubt the identity of this and the New Guinea "variety." Rosenstock [5] says, "pinnulis pinnulisque in specimine apice lato, integro desinentibus;" but the toothed apices of *A. ramosii* are one of its conspicuous characteristics.

As to the genus: The mere aspect of this fern shows it unmistakably to be an *Athyrium,* in distinction from *Asplenium.* How Hieronymus could subject the paleæ to careful study and describe them accurately and still not recognize them as characteristic of *Athyrium,* positively so known at least since Milde's time, is incomprehensible.

ATHYRIUM FORMOSANUM (Rosenstock) Copeland, comb. nov.

Diplazium formosanum ROSENSTOCK, Hedwigia 56 (July, 1915) 337.
Diplazium odoratissimum HAYATA, Icones Form. 5 (November, 1915) 273.

In Icones Form. 8 (1919) 145, these two species of *Diplazium* are identified as the same, but under the later name. We have two good specimens of the type collection of Rosenstock's species, *Faurie 188,* 1914, distributed as *Diplazium javanicum* Makino. Faurie seems to have collected the new species and typical *Diplaziopsis* together, which throws just a little doubt on the status of the new species. That is, one might suspect it of being a hybrid, if this were the only collection. The affinity of the two is quite unmistakable. There is a strong resemblance in color, texture, margin, and venation, all peculiar features; and the likewise

[5] Fedde's Repert. 12 (1913) 528.

peculiar fleshy stipes are indistinguishable. Both have thin, fragile indusia, but this is not so extreme in the new species; wherefore, it opens by its margin, breaking elsewhere only exceptionally; whereas, the indusium of *Diplaziopsis* usually breaks open elsewhere to expose the sporangia.

The chance that this is a hybrid was lessened by its independent collection as the type of *A. odoratissimum*.

A smaller plant, which seems specifically indistinguishable from this, is found in Kwangtung, on Loh Fau Mountain, by Levine, McClure, and To (1921), herbarium of Canton Christian College No. 6866.

In the same group clearly belongs *Athyrium heterophlebium* (Mettenius: Baker) Copeland, comb. nov. (*Asplenium heterophlebium* Mettenius MS. in Synopsis Filicum 243). Hayata distinguished his *D. odoratissimum* from this by its not having a toothed margin. The idea of a toothed margin of *A. heterophlebium* comes from Beddome's figure;[6] but the original description, as Beddome correctly copied it, says "the edge undulated," which agrees perfectly with the Formosa plant in its most perfect development. The Kwangtung specimen has the margin entire, as do the smaller fronds from Formosa. If it were not that the rachis is described as "villose and fibrillose throughout," while there is nothing villose about the Formosa and Kwangtung plants, they might all be regarded as one widely distributed species.

The bridging of the gap between *Athyrium* and *Diplaziopsis*, by the species just discussed, is one reason for abandoning *Diplaziopsis* as a genus. They effectively do away with the venation as a distinguishing character, although the identity of venation is not complete. The character taken as essential for *Allantodia* by Baker, and Diels, and thence for *Diplaziopsis* (merely a new name) by Christensen, is the rupturing of the indusium. This might do very well for the critical distinction of an aberrant species or group, if it were constant; but it is not so. In a series of sheets of this fern, of various origins, I find no mature frond in which all the indusia open by rupture instead of by the lifting of the distal margin. Since what has been called *Diplaziopsis* is not separated from other species now known and recognized as *Athyria* by any wider gap than cuts off various other species—*A. accedens, A. opacum, A. esculentum*, for examples—it may properly be treated in the same manner, and known as *Athyrium javanicum* (Blume), *Asplenium javanicum* Blume, Enumeratio (1828) 175.

[6] Ferns Brit. Ind. pl. 329; Ferns Brit. Ind. and Ceylon 192.

ATHYRIUM CAVALERIANUM (Christ).

Allantodia cavaleriana Christ, Ac. Geog. Bot. Mans. (1906) 293, *Diplaziopsis cavaleriana* C. Christensen, from Kweichau, is probably a near relative of *A. javanicum.* The individual pinna at the apex places it here, and distinguishes it from such species as *A. formosanum.* The likeliest clue to the exposure of the sporangia should be the genus in which Christ places it. What he says is: "Indusio nigro opaco et adiaphano carnosulo initio clauso mox corrugato sporangiisque occulto." One of the sori figured seems to show a diplazioid form and to be exposed by the lifting of both distal margins. The species should be known as *Athyrium cavalerianum* (Christ).

LINDSAYA FISSA Copeland, sp. nov. Plate 1.

Rhizomate scandente, ramoso, 2 mm crasso, atrocastaneo, paleis castaneis integris lanceolatis deciduis basibus adnatis 2 mm longis subvestito; stipitibus remotis, gracilibus, 1–4 cm longis ad basin atrocastaneis nitidis paleis minoribus caducis sparisius vestitis, sursum, rhachique plerumque laete stramineis, rarius etiam plus minus castaneis; fronde usque ad 40 cm alta, 3 cm lata, utrinque angustata, profunde bipinnatifida, herbacea; pinnis brevissime stipitulatis, dimidiatis, subcontiguis, 15 mm longis, 5–7 mm latis, recurvatis, margine superiore-exteriore profunde incisis, segmentis plerumque ca. 5, obovato-cuneatis, truncatis, apicibus aut subintegris aut irregulariter minute denticulatis; venulis tenuibus in segmentis furcatis et in segmentis inferioribus latioribus bis furcatis; soris quoad segmenta terminalibus, fere omnibus compositis; indusio rarius (sororum simplicium) Microlepioideo, plerumque lato et breve, margine crenulato, apicem segmenti non attingente.

PALAWAN, Mount Capoas, *Merrill 9527,* type in herbarium Copeland No. 7114; *Merrill 9535,* this specimen, whether or not naturally, dark-colored throughout.

This species is intermediate between *L. hymenophylloides* Blume and *L. repens* (Bory) Beddome. It is to be observed that, although both of these names are familiar, the plants themselves are much less positively so. As to *L. repens,* Brause,[7] presumably with knowledge of authentic material, says that it is known only from Mauritius and Reunion; that the *L. repens* of Beddome, Ferns So. Ind. pl. 209 (he does not mention pl. 214), is *L. pectinata;* and that the similar species common in the Philippines is a distinct one, which he calls *L. boryana* (Presl). Assuming the distinctness of the Philippine plant in question,

[7] Engler's Jahrb. 56 (1920) 129.

I do not see how it can bear Presl's name. For reasons not clear, he used a new specific name for *Dicksonia repens* Bory, identifying with it a Philippine specimen. Although his citation of synonymy is preceded by a brief diagnosis, based on the Philippine specimen, his choice of a specific name makes it clear, along with the citation, that he was not describing a new species. In the Tentamen (under *Saccoloma*) he cites both names, *repens* as the synonym. Finally, in the Epimeliae, this time under *Odontoloma,* he took cognizance of priority, and made *D. boryana* a synonym of *O. repens.*

Christ was disposed to make one species of this whole group, including also *L. hymenophylloides;* but I believe he attached a very undue importance to the occurrence of dissected fronds on supposed juvenile specimens of species whose adult plants bear entire or shallowly lobed pinnæ. They are interesting as clues to phylogeny, but do not prove anything like specific identity; gastrula and blastula stages of his embryo do not make a polyp of a fish or a man. Whether or not the Philippine fern called *Davallia boryana* by Presl ranges to India, or even to Mauritius, neither *L. hymenophylloides* nor *L. fissa* is that species. Even if *D. boryana,* under whatever name, becomes unusually dissected, so as to include forms cut more than half-way across the pinna, as is *Loher 13621,* from Tayabas, *L. fissa* is still distinct, more deeply cut, thinner, the sori farther from the margin and more uniformly composite, and the segments divaricate.

It is nearer to *L. hymenophylloides.* If we had only the original diagnosis,[8] I might, in spite of the "laciniis linearibus," identify it as that species. But a common Philippine fern fits Blume's diagnosis in its entirety, and is readily distinguished from *L. fissa* by its very much narrower and more uniform segments, with the sori usually simple. It seems not to be common in Java; for it was known to Hooker only by description when he issued the first volume of the Species Filicum, and is not mentioned by Raciborski. Whether *Davallia hymenophylloides* Baker, Icones Pl. III 7, pl. 1623, as figured, is another species, or a distorted drawing, I do not know. The figure shows the segments, as well as the pinnæ, very one-sided, which is a condition not even suggested by Steere's Luzon plant, cited in the text.

LINDSAYA RAMOSII Copeland, sp. nov. Plate 2.

Rhizomate brevi-repente, vix 2 mm crasso, pilis fusco-castaneis minutis (0.5 mm longis) vestito; stipitibus approximatis, fulvis, nudis, gracilibus, frondum simpliciter pinnatarum fertilium 7 cm,

[8] Enumeratio 218.

bipinnatarum 25 cm altis; frondibus aut pinnatis 15–20 cm altis vix 15 mm latis acuminatis deorsum non angustatis, aut compositis, cum ramis similibus sessilibus (in specimine Ramosii utroque latere uno) lateralibus paullo minoribus rhachibus gracilibus stramineis; pinnis (resp. pinnulis) approximatis et saepe imbricatis, breviter stipitulatis, late oblongis, majoribus ca. 7 mm longis, 4 mm latis, herbaceis, integris, marginibus inferiore et interiore (rhachin versus) rectis, exteriore truncato-rotundatis; venis subflabellatis, sparsissime anastomosantibus, inconspicuis; soro continuo, indusio angusto, cum margine pinnæ fere continuo.

LUZON, Cagayan Province, *Bur. Sci. 7562 Ramos,* type in herbarium Copeland No. 7118.

Related to *L. borneensis* Hooker, rather than to any species of the "Synaphlebium" group, to which the sparingly anastomosing veins would indicate a reference; probably, too, not very remotely related to *L. concinna* J. Smith. By a key, it falls with *L. azurea* Christ, but is very different in venation, judging by Christ's figure,[9] not bluish, stipes not appreciably rigid, and the fronds or their branches broad to the base.

McLean and Catalan 89, from Claveria, Cagayan, represents the same species. The fronds of this collection are all composite (bipinnate), with more-numerous and slenderer branches—one or two on a side, and 8 to 10 millimeters wide.

LINDSAYA CONCINNA J. Smith.

Schlechter 19900, 1909, from Kaiser-Wilhelms Land, distributed as *L. gracilis* Blume, is not that species, but may be identified as *L. concinna,* from which it differs, if at all, in its shiny upper surface. It differs from *L. brevipes* in the base of the frond, which is not long-attenuate. There are other reports of *L. gracilis,* which may be correct.

LINDSAYA MICROSTEGIA Copeland.

Lindsaya microstegia COPELAND, Philip. Journ. Sci. § C 6 (1911) 83.

Schlechter 17133, from Kani Mountain, Kaiser-Wilhelms Land, distributed as *L. repens,* is *L. microstegia.* The indusium is less than 0.1 millimeters long, and is usually invisible after the sporangia begin to mature. Quite aside from the character of the indusium, it is very distinct from *L. repens.*

LINDSAYA LONGIFOLIA Copeland, sp. nov. Plate 3.

Synaphlebium terrestre: rhizomate breve, radicoso, 2–3 mm crasso, paleis fuscis parvis vestito; stipitibus caespitosis, 15–20

[9] Ann. Buit. 15 (1897) 101, pl. 14, fig. 12.

cm altis, rhachibusque nudis, gracilibus, sulcatis, fulvo-straminеis; frondibus bipinnatis, pinna terminale 15–20 cm vel ultra longa, ca. 1 cm lata, utrinque sensim angustata, pinnis lateralibus utroque latere 1–3, paullo minoribus; pinnulis herbaceis, brevistipitulatis, inferioribus et superioribus multis deltoideo-cuneatis, medialibus obliquioribus, contiguis et saepe imbricatis, margine interiore 4 mm longa rhachi parallela et approximata rectis, inferiore fere 7 mm longa leviter sursum-curvatis, superiore plerumque ca. 5 mm longa plus minus curvatis et incisis, basi cuneatis; venis fere occultis, paucis, flabellatis, anastomosantibus; soris pinnularum medialium saepius 3, compositis, pinnularum superiorum et inferiorum saepius solitariis apicem totam occupantibus; indusio laete, tenue, breve, sed cum margine conterminante.

BASILAN (prope Mindanao), *Bur. Sci. 16227 J. Reillo,* 1912, type in herbarium Copeland No. 7126.

This seems to be a decidedly distinct species. It has the frond form of a slender *L. borneensis,* but differs in venation and in the shape of the pinnules. While the description has much in common with that of *L. decomposita,* I doubt their being very nearly related.

CRASPEDODICTYUM CORIACEUM Copeland, sp. nov.

Species ex C. quinato segreganda, rhizomate 8 mm crasso, lignoso, breve; stipitibus confertis, 30–50 cm altis vel altioribus, deorsum castaneis, paleis paucis deciduis atrocastaneis ovatis 1 mm longis rigidis ornatis, sursum brunneis, nudis, superne sulcatis; fronde trifoliata, glabra, coriacea, superne atroviride, inferne olivacea; pinnis integris, acuminatis, mediale 20 cm longa, 5 cm lata, brevissime pedicellata, lateralibus paullo minoribus, adnatis, interdum at basin gemmiferis; venis inconspicuis, seriem unam areolarum marginalium efficientibus. Frons fertilis deest.

SUMATRA, Benkoelen, Legong Tandai, *C. J. Brooks 191S,* April, 1913.

This is probably the same as the Bornean component of *C. quinatum* (*Gymnogramme quinata* Hooker, Spec. Fil. 1: 152), providing the first part of "subcoriaceo-membranaceous," the second part of "quinato-pedato," and the "ternate" and "decurrent at the base," the contrasting features of the description being provided by a Polynesian fern. I have from Papua what I suppose is the latter, and construe it as typical *C. quinatum* because Hooker cited the Oceanic collections first. The two are as distinct as two species of a genus ever need to be.

CRASPEDODICTYUM SCHLECHTERI (Brause) Copeland, comb. nov.

Syngramme schlechteri BRAUSE, Engler's Jahrb. 49 (1912) 32.

This is distinguishable from *C. grande*, published a year earlier, by having its veins much less crowded, and the lateral pinnæ short-stalked, instead of decurrent. As to the specimens in hand, the most conspicuous difference is that *C. grande* is trifoliolate, while this species has five leaflets.

CRASPEDODICTYUM MAGNIFICUM Copeland, sp. nov.

C. vero magnificum; stipite valido superne late et profunde canaliculato, fusco-stramineo; lamina more generis quinque-foliolata, glabra, tenuiter membranaceo, angustissime hyalino-marginata, costis utroque facie praecipue inferne rotundato-prominentibus; foliolis acuminatis, decurrentibus, mediale ultra 50 cm longa, 7 cm lata, medialibus paullo minoribus (45 x 7 cm), lateralibus 25–30 cm longis, 6.5 cm latis; venis ca. 1.7 mm inter se distantibus, conspicuis, castaneis, areolarum marginalium minorum series secunda hinc inde efformata, vena longitudinale reticulationi finem imponente intramarginale.

New Caledonia, lectore ignoto. Type in herbarium of the California Academy of Science.

The largest known species, and the thinnest. I am construing as *C. quinatum* a fern which exemplifies the aspects of Hooker's diagnosis that do not apply to *C. coriaceum*. Its leaflets are distinctly stalked, and it may pass as membranaceous when compared with the Bornean species, or with ferns in general. There is an element of red in the color of its stipe, less marked than in *C. schlechteri;* but this does not show at all, or is rather replaced by yellow, in the stipes of *C. grande* and *C. magnificum*. The latter is membranaceous in a degree I have never before seen approached in any fern with such ample lamina; when it is held against a printed page and before a light, one can read through it with ease.

The five species of *Craspedodictyum* now known may be distinguished thus:

1. Lateral pinnæ stalked.
   2. Intermediate leaflets much smaller than the medial.... 1. *C. quinatum.*
   2. Intermediate leaflets moderately smaller than the medial. 2. *C. schlechteri.*
1. Lateral leaflets decurrent to stipe.
   2. Coriaceous.... 3. *C. coriaceum.*
   2. Thin.
      3. Ternate.... 4. *C. grande.*
      3. Quinate.... 5. *C. magnificum.*

DORYOPTERIS CUSPIDATA Copeland, sp. nov. Plate 4.

Stipitibus confertis, gracilibus, usque ad 12 cm longis, atrocastaneis nitidis, deorsum paleis parvis atrocastaneis caducis ornatis, sursum angustissime alatis; fronde deltoidea, ca. 5 cm alta et lata, trifoliolata, glabra, coriacea, more D. concoloris ad basin tripinnatifida, qua specie lobis angustioribus conspicue cuspidatis et linea sorifera extus insigne nigra differt.

MINDANAO, Santa Maria, *Bur. Sci. 16515 Reillo*, 1912.

Distinguished from the Luzon plant called *D. concolor* by the more evident wing on the rachis, rather smaller and distinctly thicker frond, with narrower, conspicuously cuspidate lobes, relatively wider inflexed margin, and the black line, conspicuous from above after the protective margin expands.

The apical point, which distinguishes this plant conspicuously from the commoner Luzon species, can be matched in some American specimens; the latter, as represented here, are thinner, with less evidently winged stipe, and without the black line marking the sorus. It may be expedient to continue to construe *D. concolor* as a plant of exceedingly wide distribution; thus emphasizing the fact, equally true whether we recognize one species or a number of very similar species, that such a distribution has been reached and is maintained. The not very remotely related ferns *Hypolepis punctata, Histiopteris incisa,* and *Pteridium aquilinum* illustrate the same fact and raise the same problem; but any convenience gained by recognizing a single species as exceedingly wide-spread is more than offset, if this course keeps us from recognizing its distinct local derivatives. The African *Cheilanthes kirkii* would better be treated as a distinct species, of *Doryopteris.*

DORYOPTERIS BRANNERI Copeland, sp. nov. Plate 4.

Stipitibus confertis, ebeneis, teretibus, nudis, frondis sterilis 6 cm alta, gracile, fertilis 25 cm alta, valida; fronde sterile 6 cm longa, 4 cm lata, haud profunde lobata lobis deltoideis, obtusis, 10–15 mm latis, venis anastomosantibus; fronde fertile ca. 15 cm longa et lata, coriacea, glabra, brunnea, trifida et ad basin basiscopice tripinnatifida, segmentis basalibus deorsum basiscopice valde acutis; segmentis cujusdam ordinis similibus, linearibus, apud baseos 5–7 mm latis, apices acuminatis versus sensim angustatis, rectis vel sinuatis, valde remotis sed ala aequale media latetudine laciniarum ubique connexis.

Brazil, *J. C. Branner*, 1874.

In the polymorphic group of *D. lobata,* this most resembles *D. acutiloba* Prantl as to the fertile frond, but the sterile one

is essentially different. The narrow, remote divisions mark it off clearly from other species. It is more than thirty-five years since I marked this specimen as probably new; as it seems still to be undescribed, I take the opportunity to dedicate it to the memory of the eminent geologist who collected it.

THE IMAGINARY GENUS CAMPYLOGRAMMA

The first word on this "genus" is its original publication, as follows:[10]

Campylogramma, v. A. v. R.

Hemigrammae affinis sed frondibus fertilibus non vel vix contractis, costulis (main veins) munitis, areolis venulis liberis Aspidii more, soris rotundatis ad linearibus, in diversas partes patentibus.

By the shape of the sori intermediate between Dictyopteris and Dictyocline.

Campylogramma lancifolia, v. A. v. R., tab. I.

Rhizoma repens, intricatum, in sicco nigrum, squamulis deciduis, fuscis, lanceolatis, fragilibus vestitum. Stipites plus minusve sparsi, alati, 10–45 cm. longi, frondium fertilium quam sterilium multo longiores, glabri, parte exalata 5–30 cm. longa, ala anguste lineari-cuneata, in fronde sensim transienti. Frondes tenuiter coriaceae, glabrae, lanceolatae, acute vel obtuse acuminatae, subintegerrimae ad irregulariter subsinuatae; frondes steriles ± 25–30 cm. longae et 4–6 cm. late, costa costulisque prominentibus, costulis patentibus, rectis vel leviter flexuosis, marginem non attingentibus, inferioribus sensim irregularibus et in ala deficientibus; frondes fertiles paullo minores. Sori compitales vel ad venulas liberas positi, subrotundi ad breviter lineares, receptaculis brevioribus rectis vel subrectis, longioribus rectis, curvatis, subcircularibus, sigmoideis ad irregulariter flexuosis vel ramosis, irregulariter sparsi vel seriati et series sororum costa vel margine plerumque paralleles vel subparalleles.

The description is taken from a living specimen cultivated in the Buitenzorg Gardens.

Celebes (*Mt. Boesoe*), Capt. van Vuuren's Exploration Expedition, coll. Rachmat No. 165.

The last word I have seen was published less than two years later, as follows:[11]

Campylogramma lancifolia, v. A. v. R., Bull. Buitz. 1916, XXIII, 7, tab. I; Mal. Ferns & All., Supplem. I, 334.

Since the plants cultivated in the Buitenzorg Gardens, on which the description of this species is based, have become older, it proves that the stipes are articulated to the rhizome, a fact not to be seen in young plants even when dried. It is therefore rather evident that the genus Campylogramma (as far as regards this species, the rhizome and base of the stipes of C. pteridiformis v. A. v. R. being still unknown) is related to the genus Pleopeltis § Pleuridium and this species to Pl. Zollingeriana v. A. v. R. (=*Polypodium heterocarpum Bl.*, Flor. Jav., II, 167, tab. LXXV).

[10] Bull. Jard. Bot. Buit. II, No. 23 (1916 [?]) 7.
[11] Ibid. No. 28 (1918) 11.

I am unable to examine which of both species may probably have been the ancestor or descendant of the other or that they are both descendants of a common ancestor. While the knowledge of the often easily recognizable affinity between genera and species is very valuable for their systematical grouping, I think the tracking of their probable or apodictically pretended descent, which depends as a rule only on not to be proved suppositions or personal conceptions, is too trifling and the mention of it too worthless to take into consideration for systematical-botanical publications.

If its author had seen fit to withdraw his genus when he found that he had described it under a delusion, his closing remarks could well be ignored; but, since the genus is left standing until somebody else expunges it, the appropriateness of these words can hardly be overlooked.

In the generic diagnosis, "Hemigrammae affinis" is the major element. A genus must be placed somewhere; and, when the formal diagnosis is incomplete, the location of the genus supplies the deficiencies; for illustration, in this instance, it tells us that there is no indusium. The "easily recognizable affinity" is more than merely valuable; in my own repeatedly expressed judgment, it is the sole basis on which, as our knowledge becomes complete, genera can properly be recognized and defined. The easy recognition of affinity to *Hemigramma,* on the part of a fern with "rhizoma repens, intricatum," etc., was a mental achievement which ought not to have been disturbed by the subsequent discovery of articulate stipes. The keen botanist who separated *Hemigramma* from *Leptochilus* ignored any trace of articulation of the latter.

If *Campylogramma* had been a real relative of *Hemigramma,* but descent was an inscrutable mystery, one wonders why it might not have been a *Tectaria,* or, if not that, *Heterogonium.* If descent could be ignored, it would probably never be necessary to describe another genus of ferns. There are a considerable number of *Tectaria* species with sori of irregular shape. For example, to quote authority which the author of *Campylogramma* will hardly impeach; "D(ictyopteris) heterosora, Bedd. . . . Sory very abundant small, irregular, often confluent." [12] Unless it be the imaginary affinity to *Hemigramma,* which would not serve the purpose, there is absolutely nothing in the diagnosis of the genus *Campylogramma* to distinguish it from Beddome's fern.

However, since the author of the genus has relocated it, we can substitute *Pleopeltis* for *Hemigramma.* If we then abstain from

[12] Malayan Ferns 518.

the technicality that real *Pleopeltis* is unknown in Malaya, and agree that "the genus Campylogramma . . . is related to the genus Pleopeltis," etc., we will next be driven to wonder wherein this affinity falls short of identity. *Polypodium heterocarpum* Blume possesses in their entirety the characteristics by which *Campylogramma* was distinguished from *Hemigramma,* and was named to mark the character apparently most essential for the recognition of the "new" genus. In rhizome, paleæ, stipe, size, form, margin, texture and surface of frond, venation and fructification, *C. lancifolia* is described as identically like *P. heterocarpum,* which was long since reported from Celebes. Not to mention generic distinctness, we are not shown that it is specifically different.

Incidentally, "Pleopeltis Zollingeriana" with the entailed initials is a pure incumbrance of synonymy. There are rules, though I do not follow them, under which this fern should be called *Polypodium zollingerianum,* but there never was a rule which would justify that name in *Pleopeltis.* If it were a *Pleopeltis,* which it is not, its name would be *Pl. heterocarpa* (Blume) Moore.

As to the validity of *Campylogramma,* the status of *C. pteridiformis* v. A. v. R. is absolutely irrelevant. The genus falls with its type species. I do not suspect *C. pteridiformis* and *C. lancifolia* of being congeneric, but *Campylogramma* cannot be salvaged for application to a species that, if specifically valid, was unknown when the genus was described.

Apodictic is a very fine word. Introduced where it is, in discussing a genus originally defined as "Hemigrammae affinis," it can hardly have been aimed elsewhere than at my positive derivation of *Hemigramma* from *Tectaria*—as to which, I will accept the expression cheerfully. The recognition of affinity is conceded to be easy, so I will not waste space rehearsing the proof that *Tectaria* and *Hemigramma* are related. Of the two, *Tectaria* is more than pantropic in distribution, rich in species and with recognizable groups of species, with recognized genera derived from it, and on the other hand with "easily recognizable affinity" to a probably still older and greater genus, *Dryopteris. Hemigramma* is comparatively local, probably reaching out from Malaya only as far as New Guinea and Formosa, comparatively homogeneous, without recognized relatives other than *Tectaria,* still plastic and apparently subject to reversion to a tectarioid aspect. Most botanists will agree, on such evidence, that *Tectaria* is the older group. If there is still some mystery as to

whether the older or the younger group is the probable parent, that problem may be left for future elucidation. The dictionary says that "Apodictic or Demonstrative Judgments are subjectively and objectively sure; sure to him who holds them, and capable of being enforced upon all of sane mind."

EGENOLFIA FLUVIATILIS Copeland, sp. nov. Plate 5.

Rhizomate ad saxa in rivulis repente, 2 mm crasso, paleis fuscis lanceolatis ad et prope apicem vestito; stipitibus approximatis, frondium sterilium 5–10 cm, fertilium 12–20 cm altis, rhachibusque sordide viridibus paleis fusco-castaneis lanceolatis 2 mm longis ornatis; fronde sterile lanceolata, ca. 15 cm longa, 4–5 cm lata, pinnata, rhachi ala angustissima pinnis interrupta ornata, apice prolifera; pinnis erecto-patentibus, stipitulatis, acutis, basibus cuneatis, praecipue margine acroscopico argute grosse serratis, glabris, herbaceis, plumbeo-viridibus; venis plerisque bis furcatis, ramo mediale in dentem et distale in spinam deciduam protensis, pinnis medialibus 3 cm longis, 5 mm latis, apicem et basin frondis versus minoribus; fronde fertile usque ad 15 cm longa, 2 cm lata, pinnis oblongis, crassis, siccitate evolutis.

LUZON, Isabela Province, San Mariano, altitude 700 m. s. m., *Bur. Sci. 46986 Ramos and Edaño*, 1926.

The position, shape, and color of the sterile pinnæ distinguish this sharply from the common *E. appendiculata*. It is equally distinct from all of the species described by Fée and ignored by later writers; some of these, at least, are distinct and easily recognizable. The remarks made under *Athyrium altum* are even more applicable here.

POLYPODIUM DEORSIPINNATUM Copeland, sp. nov.

Goniophlebium Eupolypodio affine, rhizomate repente, 1–2 mm crasso, paleis castaneis sparse denticulatis lanceolatis acuminatis 2 mm longis radibusque dense vestito; stipitibus remotis, 10 cm altis, stramineis, glabris; fronde usque al 30 cm alta et 9 cm lata, deorsum pinnata, sursum fere ad rachin pinnatifida; pinnis et segmentis frondis adnatis, 7 mm latis, fere horizontalibus, obtusis, praecipue sursum argute haud profunde serratis, papyraceis, omnino glabris; venis aut anastomosantibus et seriem unam areolarum includentibus aut liberis et triramosis; soris orbicularibus vel sub-oblongis, superficialibus.

FORMOSA, Mount Arisan, altitude 2,500 m. s. m., in rupibus, *Faurie 581*, June, 1914.

More like *P. nipponicum* than the other related species, but conspicuously different in being naked. It stands to *P. vulgare* in much the same relation as does *P. californicum*.

POLYPODIUM BONGOENSE Copeland, nom. nov.

Polypodium brooksii COPELAND, Philip. Journ. Sci. § C 12 (1917) 60, non C. Christensen, Index Suppl. (1913) 4 or 58.

LOXOGRAMME PARALLELA Copeland, sp. nov.

As originally described, this was a very small fern; and, in treating the genus,[13] I distinguished it from *L. linearis* in the key to the species, by its having fronds under 20 centimeters long. We have very many collections of it from the Benguet region, in just one of which the largest fronds reach a length of 22 centimeters. Their usual length is 15 centimeters or less. A fern found on Mount Kinabalu, which I have regarded as this species, is moderately larger.

I have now from Mount Matutum, in Mindanao, a fern otherwise very similar, but with fronds reaching a length of even 50 centimeters, and therewith a width of about 15 millimeters, rarely more. In this collection, few plants fail to have some fronds over 25 centimeters long. In the absence of other evident good distinctions, I am letting this pass for the present as *L. parallela.* Further collection should show whether or not the gap in stature is constant. This large plant is not *L. linearis,* a Formosan species, distinguished by size in the key referred to (loc. cit. p. 44). The sori of the latter overlap, but those of this large *L. parallela* are strictly seriate.

LOXOGRAMME SCOLOPENDRINA (Bory) Presl.

Loxogramme scolopendrina (Bory) PRESL, Tent. Pterid. 215.

Antrophyum involutum BLUME, Fl. Javae (1828) pl. 37. fig. 1, excl. syn.

Grammitis scolopendrina BORY, Voy. Coquille (1829) 257, pl. 30, fig. 1.

Selliguea flavescens J. SMITH, Journ. of Bot. 3 (1841) 399, excl. syn.

Bory's plant and Blume's seem to be absolutely identical. In distinguishing his *Antrophyum coriaceum* and *A. avenium* (both first as *Grammitis*), Blume particularly emphasized the carinate character of the costa of his *A. involutum,* the others having it flattened beneath and prominent above. This is a distinguishing characteristic of the species, which ranges throughout the Malay region and for some distance onto the continent. Bory's specimen was accredited to New Zealand, but this origin is doubted.

LOXOGRAMME AVENIA (Blume) Presl.

Loxogramme avenia (Blume) PRESL, Tent. Pterid. 215.

This name has priority over *L. blumeana* Presl, the plants being regarded as identical.

[13] Philip. Journ. Sci. § C 11 (1916) 43.

LOXOGRAMME INVOLUTA (Don) Presl.

Loxogramme involuta (Don) Presl, Tent. Pterid. 215.
Grammitis involuta Don, Prod. Fl. Nepal. (1825) 14; Hooker and Greville, Icones Fil. (1828) Pl. 53.
Grammitis flavescens Wallich, nomen.

All of our specimens from northern India, including authentic *G. flavescens,* are alike in having the costa prominent, but not carinate even at the base. I have tried unsuccessfully to locate a type specimen of Don's fern, collected by Hamilton, but am glad to acknowledge the assistance of Mr. William Smith, regius keeper of the Royal Botanic Garden, Edinburgh, where I thought such a type might exist. The plants of northern India differ again from those of Malaya in commonly having much longer sori. I doubt that the two species meet. My only Yunnan specimen, *Henry 9059c,* received as *Gymnog. involuta,* is referable to neither of them; it may be *L. fauriei,* which seems to be common in some parts of China.

CALYMMODON ASIATICUS Copeland, sp. nov.

Caudice 0.5 mm crasso, breve, radicibus et axibus frondium emortuarum incrassato, apice paleis ferrugineis ca. 1 mm longis lanceolato-ovatis vestito; stipitibus caespitosis, 1–3 mm longis; fronde plerumque 3–4 cm longa, 5 mm lata, ad alam angustissimam costae ad stipitem etiam decurrentem pinnatifida, praecipue ad costam pilis pallide fulvis 0.4 mm longis deciduis ornata; segmentis sterilibus patentibus, frondium majorum 3–3.5 mm longis, ca. 0.8 mm latis, apice rotundatis, paucis et sese remotis, infimis aut aequalibus aut paullo brevioribus et acutioribus nullibi valde diminutis; segmentis fertilibus vix 2 mm longis, conduplicatis 1 mm latis subacutis, explanatis quam latis latioribus, supremis latissime adnatis, aliis costam frondis versus modo contractis et angustius adnatis; soro elongato.

Annam, Mount Bana, *J. and M. S. Clemens 3800,* on bowlders in shaded ravines, May–July, 1927.

Nearest to *C. ordinatus* Copeland, Philip. Journ. Sci. 34 (1927) 267, but smaller, with smaller paleæ, the sterile segments slenderer and decidedly more remote, and without the characteristic long sequence of uniform fertile segments. The collection is of not less than one hundred very uniform plants.

ILLUSTRATIONS

PLATE 1. LINDSAYA FISSA COPELAND, SP. NOV.; TYPE.

PLATE 2. LINDSAYA RAMOSII COPELAND, SP. NOV.; TYPE.

PLATE 3. LINDSAYA LONGIFOLIA COPELAND, SP. NOV.; TYPE.

PLATE 4. DORYOPTERIS BRANNERI COPELAND, SP. NOV.; TYPE.

PLATE 5. EGENOLFIA FLUVIATILIS COPELAND, SP. NOV.; PART OF TYPE COLLECTION.